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FILL FOUNDATION TREATMENT FEATURES HIGH EMBANKMENT ROADS

Fill Toe and Cut Off Trenches Built as Huge French Drains

By A. M. WALSH

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AFTER making several alternate location surveys for the Los Gatos-Santa Cruz highway, decisions finally adopted represent the largest combined values which the engineers could arrange under the limitations of acceptable alignment, grade, and distance. Alignment on the existing road is obsolete as compared with present standards for this class of highway. While the new location uses a little higher rate of grade than the old road, it reduces the travel distance nearly 2½ miles, and decreases central curvature from 7,700 degrees to 1,170 degrees. The following table clearly illustrates the benefits that the new construction will effect:

	Existing	*Design*	*Difference*
Length	43,142 ft.	30,518 ft.	12,624 ft.
No. of Curves....	132	20	—112
Total Curvature..	7,700 deg.	1,170 deg.	—6,530 deg.
Maximum Radius..	1,500 ft.	3,000 ft.	
Minimum Radius...	75 ft.	500 ft.	
Maximum Grade..	6%	7%	
Highest Elevation..	1,679 ft.	1,806 ft.	†127 ft.
Lowest Elevation..	536 ft.	536 ft.	
Total Length of 7% grade.....	00 ft.	10,800 ft.	
Total Rise & Fall.	1,402 ft.	1,640 ft.	†238 ft.

In addition to the above, it is interesing to note that 40 of the 132 curves on the old road have a radius of 100 ft. or less. The terrain is mountainous and generally wooded.

Traffic: Traffic over this section of California Route 5 is in large volume through the year and very heavy during vacation season, all week ends, and holidays. Truck traffic on week days averages 9 to 20 per cent. The total traffic count of January Sundays for the years

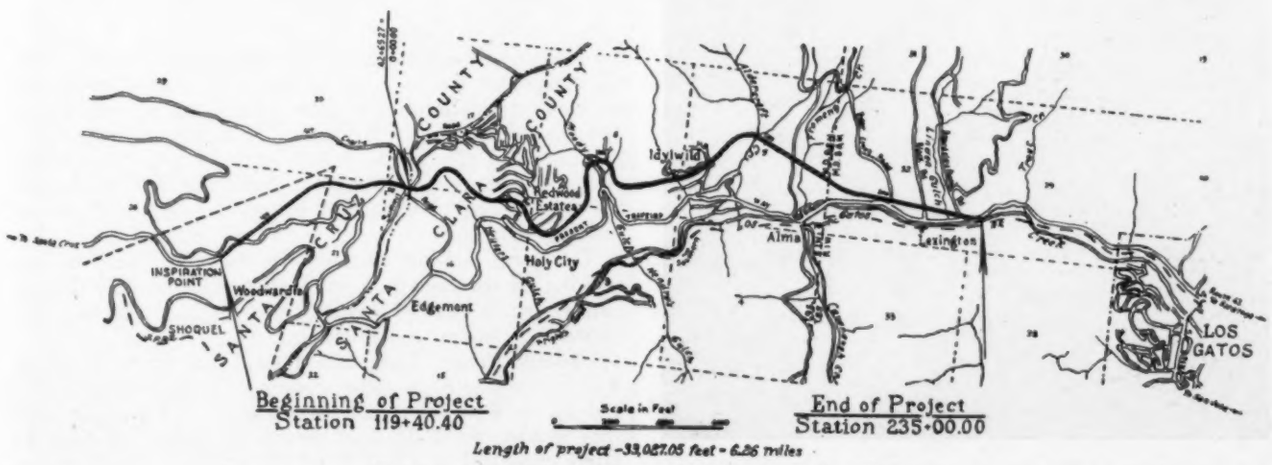


Fig. 1.—Plan of the Present and New Road Locations

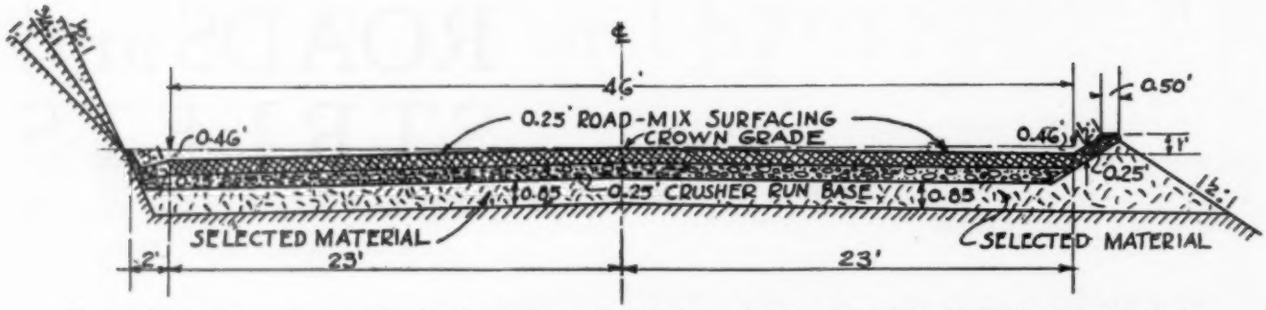


Fig. 2.—Typical Cross-Section Showing Earth Guard Rail (Dyke) and Selected Fill Material Depths Below Surfacing

1932-35 inclusive, was 11,310 compared to the total July Sundays of 37,580; a ratio of 3⅓ to 1. Horse drawn vehicles and tractors are negligible; busses, however, average about 20 per day during the summer months.

Location: The location crosses the summit ridge which is the boundary between Santa Clara and Santa Cruz counties. The hill slopes vary from moderate to steep, with general incline about 1,200 ft. per mile normal to the valley axis. The very ruggedness of the terrain is more or less assurance that the earth materials and stratigraphic forms are fairly favorable to stability, especially when provision is made for sub-drainage. While there are no low level marsh areas, there are sections with soil mantle carrying heavy seepage and some of these had to be encountered. It is this condition which brought about the interesting features of design and construction of this road. Of course, to most people, cuts and fills of 150 ft. in depth or height are interesting, in themselves, but in addition the field procedure for fill foundation treatment brings out new methods of drainage control.

Fig. 3.—Surface of Fill Area Showing Where Drainage Trenches Were Dug and Backfilled With Ungraded Quarry-Run Rock. This Work is a Feature of This Job

Fig. 4.—Showing Trench in Existing Channel Dug by a Bulldozer

The large saving distance in the new line, to say nothing of the added safety features in the new design, amply justifies the $1,064,000 grading and roadmix surfacing job under construction.

Present Road: The present road is a 15 to 17 ft. by 4½ in. portland cement concrete surface flanked by 1½ ft. by 4 in. oil treated shoulders. The present road was graded in 1915 and paved in 1922. It may be fairly classified as Class D of the standard classification. The shoulder surfacing was added in 1929, 1930 and 1931 as maintenance.

Fig. 5.—Showing Bulldozer Backfilling Trench Across Roadway Fill Area. Note Size of Quarry-Run Rock

New Design: The new design, now under construction by Heafey-Moore Co., and Frederickson-Watson Co., Oakland, Calif., as the contractor, provides a roadbed for a 4-lane highway with 3 ft. shoulders. On all fills there is being constructed an earth guard rail, termed "dykes" by the California State Highway Department. They are mounds of earth built 1½ or 2 ft. high on the fill shoulder edges. Plans call for bituminizing the face of these guard rails. The typical cross section shown herewith illustrates how they are constructed.

The top course of the subgrade will be select roadway excavation topped with crusher run rock base and a wearing surface of bituminized crusher run base materials road-mixed and compacted over the roadbed, shoulders, gutters and roadside face of the guard rail (dykes). All soil foundations were tested, particular attention being given to the soils upon which heavy embankments are to be placed. Extensive trenching, stripping and rock filling is being done to safeguard the fills against slippage.

On the major fills, toe walls are being built of quarry run rock. They are 30 ft. high and 30 ft. thick as shown by Fig. 15.

Drainage: The average rainfall in this section is about 40 in. annually, of which 23 in. occurs during the winter. The maximum 24 hr. rainfall is about 8 in. while the average seasonal snowfall is about 1 in. During one storm last winter 5.75 in. of rain fell in 16 hrs.

All corrugated metal pipe culverts employed under high fills are heavy gauge and double riveted. Most of the drainage areas are dry but provision must be made to care for seepage. The troublesome features of drainage are due to springs and seepage areas caused by water impounded in the soil overlying strata of shale and other dense materials. Because of the prevailing manner of bedding there are numerous locations with permeable beds of sandstone lying over beds of shale. Many of them are not evidenced until construction discovers them.

Under very high fills heavy reinforced concrete arch culverts are constructed on trenched rock filled foundations where the required waterway is more than 6 or 7 sq. ft. If a drainage area calls for a 24 in. circular area a 30 in. diameter corrugated metal pipe is installed. All culvert pipe are coated completely with asphalt.

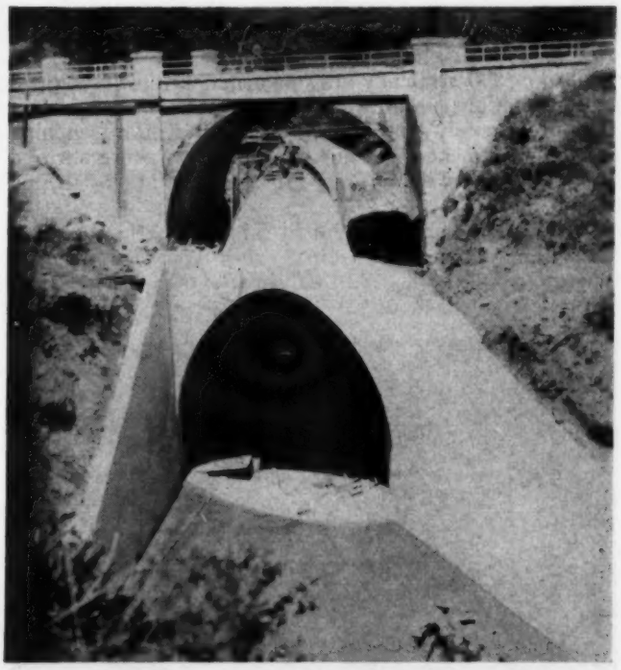


Fig. 7.—Type of Heavy Reinforced Concrete Arch Culvert Constructed. The Old Arch Bridge Will Not Be Removed, Merely Completely Buried in the Fill

Fig. 6.—A 36 in. Corrugated Metal Culvert Containing Both Vertical and Horizontal Curvature

Clearing: Clearing on this project is a considerable item of the work to be done. A large portion of the timber is dense redwood, mostly second growth, 2 ft. to 4 ft. in diameter, but also with a considerable number of large trees of the virgin forest, together with large stumps left from the original logging of this area. Typical grubbing practice is followed; dynamiting the stumps and snaking the logs and roots off the right of way by crawler tractor and teams. Altogether there is about 114 acres of clearing in the job. The cost for this work runs about $541 per acre. About 40 buildings must be removed from the right of way. Most of these buildings are shacks and small cottages, but a

Fig. 8.—Quarrying Rock Backfill Material for Both Toe Trenches and Cross Roadway Trenches. A Northwest 80, 2½ Yd. Shovel, Loads Rented Trucks. A Sullivan 210 and Ingersoll-Rand 320 Air Compressors Provide Drilling Power at the Quarry

few of the more pretentious houses were unavoidable. Cost of removal of these were included in the provisions of the right of way agreements.

Numerous water service pipe lines and water tanks were encountered. Generally, these are protected. Those belonging to corporations are rebuilt or relocated by the owners under right of way provisions.

Grading: Practically all materials are of sedimentary formations—shales, sandstone, and some clay.

Approximately 80,000 cu. yds. of rock for trenching and fill treatment in Santa Clara County were secured from quarry in the vicinity of Sta. 248 at North end of job.

Rock of similar treatment in Santa Cruz County was hauled an average distance of 8 miles from Scotts Valley Quarry to the job. A total of 50,000 cu. yds. was secured from this source.

Fig. 9.—Rolling Rock Backfill Foundation Prior to Building Arch Culvert

The laboratory forces made extensive investigations of the geology along the new location. Outstanding geological features are as follows:

a. The region represents a series of geological periods and is structurally complex.

b. About 1½ miles south of Los Gatos a vast ridge or dyke of basaltic lavas cross cuts the country for miles in a northwest and southeast direction, and is itself cut through by the erosion valley of Los Gatos creek. This dyke is associated with the unconformities and major disturbances which have marked the region with zones of heavy faulting and some land displacements on a large scale.

c. At least 2 parallel major fault planes are crossed.

d. Surface conditions preclude the possibility of accurate determination of stratigraphic patterns in any continuous sequence; and generally, the decomposed top soils are in depths exceeding 20 ft.

e. The dominant materials are shales and soft sandstones. In some locations they are decomposed to known depths of 60 ft. Generally, where sandstone overlies

Fig. 10.—Grading With Tractor Scraper Outfits on a 30 Per Cent Grade. Eight Tractor-Scraper Units, One Tractor-Bulldozer Unit, and One Tractor-Multiple Sheepfoot Roller Unit Comprises This Outfit

shale, water is impounded and seeps along the plane of contact, becoming a menace according to the dip of the strata in relation to the roadway location.

Special treatment for fill areas involve quantities as follows:

Trenches and stripping, cu. yds....	187,740
Rock, cu. yds.....	114,120
Overhaul on rock, sta. yds.....	36,000,000

As shown by Fig. 16, lateral underfill seepage cut off trenches are run where indications show that slippage

Fig. 11.—Outfit at North End is Divided. This Picture Shows a Caterpillar RD8-Wooldridge Scraper Unit Dumping on Fill Being Compacted by Cletrac 85 Equipped With Cummins Diesel Engine and LeTourneau Bulldozer

of the fill is probable if the cut off trenches are not installed. All seepage lines and points of suspected seepage, indicated by the geological formations, are intercepted by these rock filled trenches which vary in depth and width but average 12 ft. wide by 5 to 15 ft. deep. As indicated by the figure, it was deemed advisable to construct a foundation trench back filled with

Fig. 11A.—Cummins Diesel Equipped Cletrac Spreading and Rolling Another Fill on the Payton End of the Job

rock on which to build the heavy arch culvert. The old creek channel is shown by the crooked dotted line.

Overhaul: Overhaul for the ordinary cut and fill balances is calculated at about 18,000,000 sta. yds. Along

Fig. 12.—Construction Roadways to Start Scraper Operation Is Accomplished by Three Bulldozers Working Together. Bulldozers Just Visible on Opposite Mountain Side

Fig. 13.—Tractor Scraper Outfit at Los Gatos End Making Heavy Fill. Units Haul on a 30 to 40 Per Cent Grade

about 20 per cent of the line in the cuts the excavated material is suitable for fill up to subgrade elevation. On the balance of the route cuts and fills will have to be brought to a grade about 10 in. below subgrade elevation and suitable materials hauled in for topping. For practical purposes, calculations for balance and overhaul were made on the basis of rough grading to an elevation 1.35

Fig. 14.—Some of the Soils Are So Hard That Rippers (Scarifiers) Are Necessary to Start the Construction Roads and Trenches, Even on Stiff Grades

ft. below profile grade through the job. This allows 0.85 ft. for select topping.

Swell: A swell factor of 5 per cent was applied to the whole excavation yardage. Through the forested areas top soil to a depth of several inches is full of forest litter and humus. In addition to the fill foundation trenching there is approximately 30,000 cu yds. of stripping of unsuitable material to use in heavy embankments. The extensive sections of side hill filling also accumulates considerable loss to be covered by the shrinkage factor. On several locations excess clay is wasted on the upper side of gulch fills.

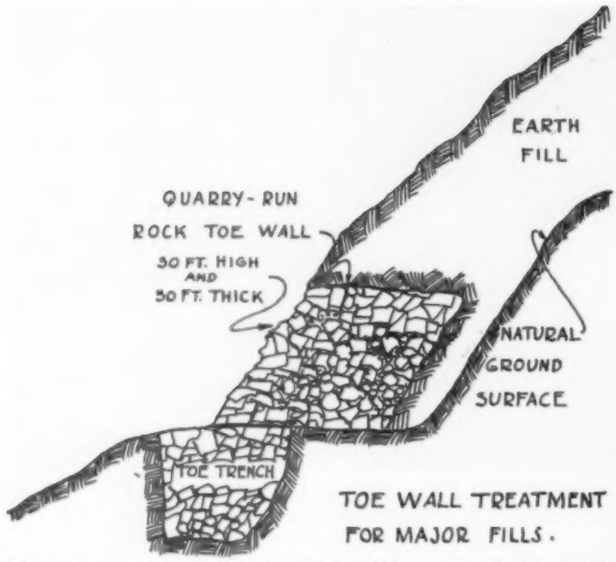


Fig. 15.—Sketch of Fill Toe Wall. These Are Built on All Major Fills

Several places in deep cuts are expected to fall or slide. This has been estimated at about 5 per cent of total excavation (about 100,000 cu. yds.). An average overhaul of 15 stations is anticipated for slides, making 750,000 sta. yds. additional to that given hereinbefore. Cut slopes have been designed with a view to slide prevention as far as is reasonable within the restraints of economy and good judgment. However, some slides have already occurred, others will. These slides are of the fall rather than the creeping type, and are due to weak, soft shale formation rather than unfavorable position of bedding planes.

Construction Program: Grading is the control item on the job. The work got under way last fall, primarily clearing and grubbing. During the 1938 fair weather season it is expected that the grading will be completed. To determine the rate of progress as well as to keep an accurate record of cost, the contractor is counting each load from cut to fill. One man keeps a record of

a. The number of the tractor-scraper unit.
b. The name of the skinner.
c. The time, to the minute, that each unit passes the counting station.

The job is expected to be completed in June, 1939, including surfacing and everything. During the spring when it was too wet for tractor operation, a Koehring dragline was used to do stripping; the material was truck hauled away.

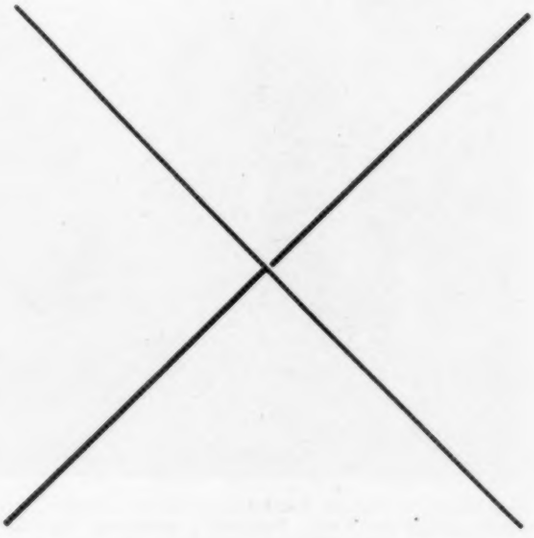
Fig. 17.—Toe Trench Ready to Backfill and Lateral Cut Off Trench Already Backfilled

SAMPLE OF COUNTING RECORD KEPT BY CONTRACTOR ON MAJOR GRADING OPERATIONS

P. M. Tractor Check.
August 16, 1938.

EIGHT-HOUR SHIFT

	Bulldozers						
	D8-No. 8 Blackman	D8-No. 12 Leaviet	D8-No. 13 Fair	D8-No. 14 Mancebo	D8-No. 9 Sufficool	50-No. 4 Methias	75-No. 3 Mosier
All tractors are hauling from Sta. 151 to Sta. 147.	1:33 7 1:40 8 1:48 8 1:56 8 2:04 7 2:11 8 2:19 8	1:33 8 1:41 8 1:49 8 1:57 8 2:05 6 2:11 8 2:19 8	Arrived from No. 112 2:00 9 2:09 7 2:16 7 2:23 8 2:31 9 2:40 8	1:34 9 1:43 8 1:51 8 1:59 8 2:07 8 2:15 9 2:24 8	Working at No. 147 with BD	Working at No. 147 with BD and Tamp.	Arrived from No. 112 at 7:00. Working at No. 151 with BD
Actual working time of tractors:	2:27 9	2:27 8		2:32 7			
Hrs.							
D8-No. 8..... 7							
D8-No. 12..... 8	7	9	10	7			
D8-No. 13..... 7¾	7:25	7:00	7:14	6:46			
D8-No. 14..... 8	8	9	8	10			
D8-No. 9..... 8	7:33	7:09	7:22	6:56			
50-No. 4..... 8	7	8	6	9			
75-No. 3..... 8	7:40	7:17	7:28	7:05			
Total number of pay yards hauled from No. 151 to No. 147 during this shift, 2,170	8 7:48	8 7:25	7 7:35	8 7:13			
Number of trips.....	51	54	52	60			
Number of pay yards...	510	540	520	600			
Average time per trip (minutes)	8½	9	8½	8			



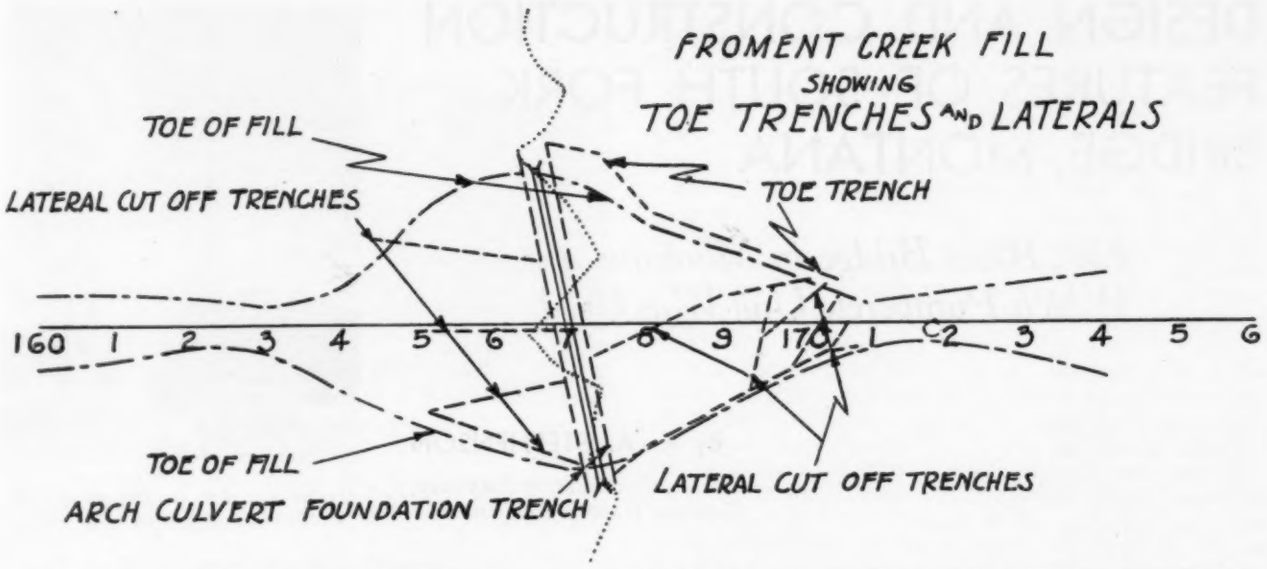

FROMENT CREEK FILL
SHOWING
TOE TRENCHES AND LATERALS
TOE OF FILL
LATERAL CUT OFF TRENCHES
TOE TRENCH
160 1 2 3 4 5 6 7 8 9 170 1 2 3 4 5 6
TOE OF FILL
ARCH CULVERT FOUNDATION TRENCH
LATERAL CUT OFF TRENCHES

Fig. 16.—Diagram of Fill at Froment Creek Showing Characteristic Fill Toe Trenches and Lateral Side Hill Trenches as Well as Culvert Foundation Trench, all Backfilled With Quarry-Run Rock. These Are Really Huge French Drains Under the 120 Ft. Fill.

At the present time grading is progressing at three points. At the Los Gatos end the contractor has an outfit of 8 tractor-scraper units. All tractors are Caterpillar D-8. All but one of the scrapers are LeTourneaus in two sizes. One of the scrapers is a Wooldridge 20-yd. loose measure unit. Four tractor-bulldozer units of which one also is used for multiple sheepfoot roller operation and one is occasionally used with a LeTourneau scarifier, operates with the grading outfit. On the rock backfill work two Caterpillar tractors with LeTourneau bulldozers handle the quarry run rock in both the trenching and the fill toe wall construction. One tractor with Wooldridge bulldozer attached cleans up the edges of the cuts and pushes on the scrapers to held load in the hard shaly and soft sandstone strata. Grading continues in two 8-hr. shifts. Electric lighting is provided along the edge of the cut slopes and across the fills.

Midway on the job three tractor-bulldozer units are opening the construction roads for operation of the tractor-scraper units.

At the Santa Cruz end the contractor has eight 14-yd.

Fig. 18.—Beginning One of the High Fills at the Los Gatos End. An International Truck is Used for Service Work

Fig. 19.—Mr. J. P. Guerin, Contractors Superintendent

Fig. 20.— Mr. A. M. Walsh, Resident Engineer

LeTourneau scrapers and D8 Caterpillar units making the cuts and fill, and one Caterpillar-Wooldridge scraper outfit. Four Cletrac 85 Tractors equipped with Cummins diesel motors and LeTourneau bulldozers work on the fill, alternating with towing the three sheepsfoot rollers. He also has 4 RD8 Caterpillar Tractors with LeTourneau bulldozers cleaning up and helping the loading.

One Caterpillar 30 is equipped with a 110 cu. ft. compressor which is used where needed for drilling, tamping, or operating a bit sharpener.

Those Responsible: This 6¼ mile job between Los Gatos and Santa Cruz involves nearly 2,000,000 cu. yds. of excavation that is being done by Heafey-Moore Co. and Frederickson-Watson Co. as the contractor, under the supervision of Col. J. H. Skeggs, Dist. Engr., District IV, Division of Highways, State of California. Superintendents J. P. Guerin and Chas. Frederickson are in direct charge of construction for the contractor. A. M. Walsh is Resident Engineer.

▼

IDAHO ONE CENT DIVERSION MOVE FAILS.—A recent report to the National Highway Users Conference states that an initiative petition in Idaho providing for a flat $5 automobile license fee and diversion of one cent of the state's 5c gasoline tax did not secure sufficient signatures to be placed on the ballot at the November election.

DESIGN AND CONSTRUCTION FEATURES OF SOUTH FORK BRIDGE, MONTANA

First River Bridge in Montana on Which Pumpcrete Unit Was Used

By R. A. STEPHENSON

Bridge Construction Engineer, Montana Highway Department

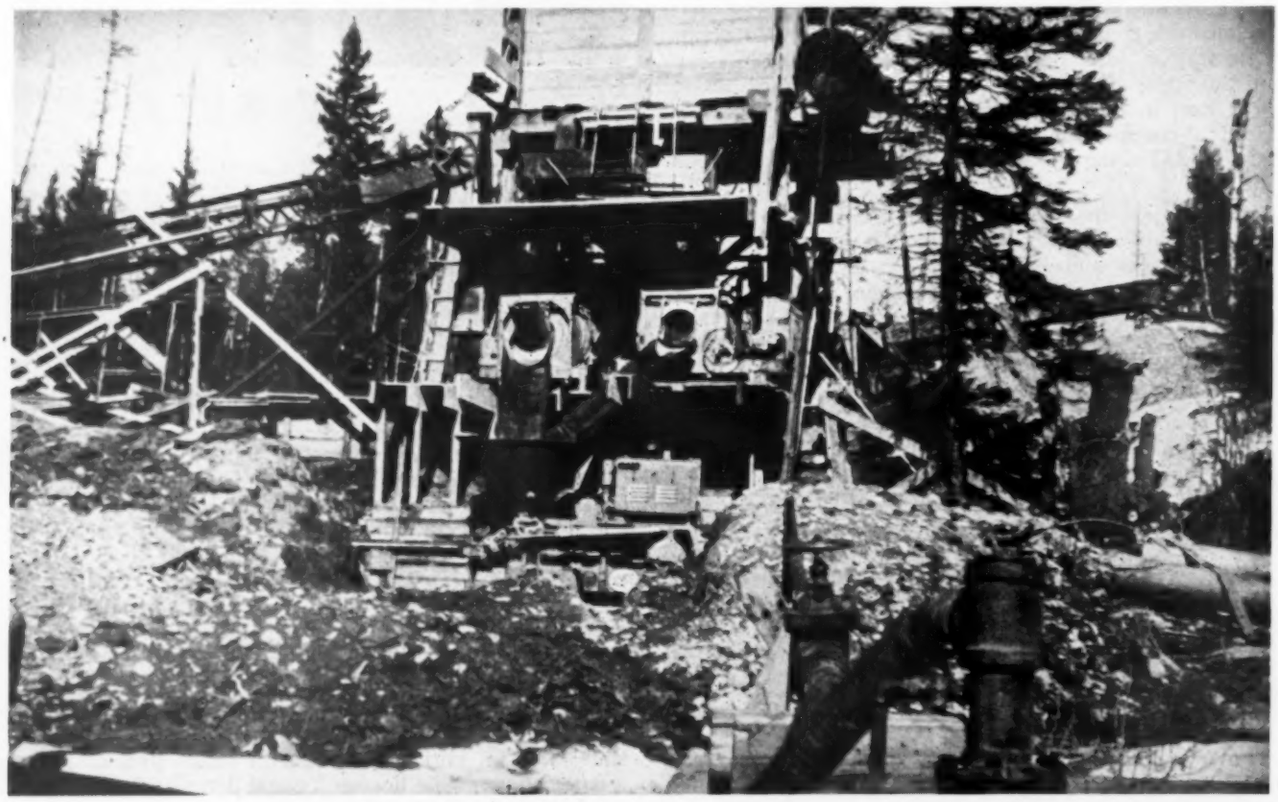
Dynamiting Ice in December, 1937, Preparatory to Setting Cofferdams.

A NEW bridge over the South Fork of the Flathead River, about ten miles from the west entrance to Glacier National Park on U. S. Highway No. 2, will be completed by the Montana Highway Department some time this Fall. The principal location and design considerations, construction procedure, and the cost of construction are reviewed in this article.

Location Considerations

The river at this point lies in a narrow valley flanked on either side by mountains whose heavily timbered slopes rise abruptly from the valley floor. The highway follows down the valley, or canyon, and in order to maintain an alignment suitable for present-day high speeds, it was necessary to place the structure on a skew, with a reasonably sharp curve on each approach. By choosing one of the wider points in the valley for the crossing, it was possible to keep the approach curves at each end down to a 3-degree and a 6-degree curve, respectively, with the structure skewed 45 degrees. The structure itself is on a short tangent.

The new structure replaces an old bridge about 1,200 ft. downstream. The old structure, built over 25 years ago, consists of three 102-ft. combination timber and wrought-iron through-trusses with a 75-ft. timber pile trestle approach on each end. Although the timbers in this bridge have been renewed from time to time, it is



Mixing Plant and "Pumpcrete" Set-Up—Aggregates Are Placed in Bins by Means of Dragline (Boom of Which May Be Noted in Right Rear). Cement Is Supplied from Belt Conveyor Located on Left. Weighing Scales for Proportioning Mix Are Located Below Bins. Pumpcrete Unit is Supplied from the Two Mixers Working Alternatingly.

Excavating for Pier 6.

now in a state of poor repair and wholly inadequate for modern traffic, both from the standpoint of carrying capacity and alignment.

Superstructure Design

The design loading is H-15 of the specifications of the American Association of State Highway Officials.

Wash borings taken prior to making the design showed that the surface material consisting of gravel and boulders extended beyond any possible depth of scour, thus permitting the use of relatively shallow piers. The length of the spans were determined from cost comparisons which took into consideration the corresponding pier costs. Relative advantages of simple and continuous spans were also considered.

The layout, as finally determined, provides for an overall length of 590 ft., composed of five deck steel plate girder spans with a 23-ft tower end span on each end. The deck girder portion has a 3-span continuous center section with span lengths of 110 ft. 8 in., 137 ft. 8 in., and 110 ft. 8 in., respectively, and one 92 ft. 6 in. simple span on each end. The bottoms of the girders are curved to provide a greater depth over the supports for the negative moments in the continuous section, and in the interest of appearance, similar curved bottoms are provided in the simple spans. The roadway width between curbs is 26 ft. The handrailing is made up of two precast concrete rail units supported by cast-in-place concrete rail posts spaced at about 6-ft. centers.

The girders are spaced at 15 ft. 3 in. center to center. The roadway slab is supported on transverse cross beams resting on top of the girders. The cross beams are spaced at 6-ft. centers and extend the full width of the roadway slab.

Substructure Design

The piers are supported directly upon the gravel and boulder formation at a depth of 13 feet below the stream bed; a depth considered safely below possible scour. Since ice gorges sometimes occur in the river at this point, in addition to dead, live, and wind loads, the four main river piers were designed for a theoretical ice load applied at the high water line. Foundation pressures were limited to 3.5 tons per square foot.

Construction Procedure—Substructure

In planning his operations, the contractor took into consideration the anticipated length of the open construction season, and the ordinary high-water period. The South Fork River heads in a mountainous territory visited by an annual snowfall of 300 to 400 in. Compacted snow, late in the winter, reaches a depth of 80 to 90 in. In case of a prolonged warm spell in the Spring, or if a series of rains occur at this time, the run off is extremely rapid and a serious flood condition results. Inasmuch as the contract was awarded in November, and as the normal high-water period usually does not occur until late in May, it was planned to excavate for and pour, the entire substructure during the winter months. Cold weather concreting is common in Montana, especially in the case of substructures which are relatively easy to protect from freezing. As a matter of fact, due to the extreme low water conditions that prevail during the winter, it is often cheaper to provide the necessary protection from freezing than take care of the water conditions which are likely to exist during the warmer months.

With the prospect of six months of work prior to the expected high-water period in which to construct the piers, the contractor constructed falsework across the river and began excavating. It was the plan to complete the excavation for all of the eight foundations, and then make all pours progressively from one mixing plant set up on the east end. Placing of the concrete was to be made with a Rex Pumpcrete unit. Incidentally, this is the first river bridge constructed in Montana on which a pumpcrete unit was used.

The above plan was followed with the result that placing of concrete began on April 4 with the pouring of the seal in Pier No. 6. Pouring went ahead rapidly; however, unseasonable warm weather combined with heavy rains caused a rapid rise in the river with the result that it was necessary to suspend all operations on April 16. At that time, the seal had been poured in Pier 3, the footings were complete for Piers 4 and 5, and Pier 6 was complete. This high water, which was the highest in 9 years and fully a month earlier than any previously known high-water period, brought down an unusually large amount of drift which had been accumulating on the banks and the falsework was entirely destroyed.

Following the first rise, and partial recession of the flood, two later rises occurred and it was not until June 21 that work could be resumed on a full scale. The contractor, however, constructed low falsework and completed pouring the river piers between the flood periods. Operations were carried forward at all possible times due to the precarious conditions of the cofferdams and the resulting danger of complete loss; however, all river piers were completed without the loss of a single cofferdam, although it was never considered safe during this period to relay the discharge pipe line from the pumpcrete unit. Therefore, the pumpcrete method was abandoned temporarily and the old method of transporting concrete in wheeled buggies was employed. The pump-

Picture Taken April 18, 1938. Note That One Span of Falsework Has Been Destroyed by Flood.

Erecting Girders.

crete unit will again be used in placing the concrete for the roadway slab.

The above experience clearly illustrates the truth that all experienced bridge contractors know—That in spite of the most carefully laid plans, there is always the element of chance in bridge construction of unprecedented floods.

With the return of normal water conditions, the work progressed rapidly and steel erection was begun on July 25. Erection was completed on August 12 and riveting started on August 16. At the time of writing this article, it is expected that pouring of the deck slab will be under way early in September. This should insure completion about Nov. 1, 1938.

Pier excavation was made with a gas-operated hoist equipped with a swinging boom and clamshell bucket. The rig was of the skid type.

Six-inch groove-and-spline timber sheet piling was used for the cofferdams.

Steel Erection

In order to eliminate as many field splices as possible, the girders were fabricated in sections ranging from 65 ft. to 93 ft. in length. The girders were hauled from the nearest shipping point, about 3 miles distant, with trucks and heavy duty trailers. In erecting the girders, the contractor constructed a standard gauge railroad from the unloading point at the bridge site to the far end of the falsework. A derrick was mounted on a push car operating on the track, and this derrick, with the aid of another in the material yard, loaded the girders, one at a time, upon other push cars. The girders were then propelled out on the falsework to the position of erection by means of a cable-pull. At this point, a third crane operating from the falsework, together with the push-car-mounted hoist, placed the girders in their final position.

Contract Data

The contract for the construction of the South Fork Bridge was awarded to Thomas Staunton, of Great Falls, Montana, on the low bid of $138,740. Work began in November, 1937.

Structural steel was fabricated by the Minneapolis Steel and Machinery Division of the Minneapolis-Moline Power Implement Co. The Bethlehem Steel Co. furnished the reinforcing steel. Kay-Brunner Steel Products, Inc., furnished the cast steel. Cement was furnished by the Three Forks Portland Cement Co. Concrete aggregates were produced locally.

Contract quantities and unit prices of the principal items entering into the bridge (exclusive of road approaches) were:

Structural steel (708,700 lb.)	$ 0.072
Cast steel (11,980 lb.)	.17
Reinforcing steel (168,200 lb.)	.06
Class "A" concrete (1,315 cu. yd.)	19.55
Class "D" concrete (453 cu. yd.)	30.00
Concrete curb and rail (1,090 lin. ft.)	3.30
Structure excavation—bents (1,024 cu. yd.)	2.40
Structure excavation—piers (1,504 cu. yd.)	6.90

The project is being financed from Federal and State funds as a regular Federal Aid Highway Project. Supervision is being handled by the Montana Highway Department; D. A. McKinnon, State Highway Engineer. A. W. Jones is the project engineer for the State.

CONCRETE JOINTS IN WOOD CONSTRUCTION

A design detail developed for buildings of the 1939 Golden Gate International Exposition is worth consideration for other uses, including highway bridges. It consists of a compression block of concrete, poured into the space between the ends of members meeting at a panel point, and is used on the 136-ft. arches of the Ford Motor Company's building.

These arches were fabricated on the ground in a horizontal position. At joint L1 of the lower chord, where compression forces predominate, five timber members were jointed by means of a ⅜-inch steel gusset plate which took care of all tension forces. Concrete was poured through a hole in the top plate forming a concrete block 12 in. thick at the core of the joint. Bolts connecting the block to the steel plates also act as reinforcement for the concrete which is capable of withstanding very large compression loads.

Arches 55 feet in height from bottom to the top pins are spaced 40 feet apart. Purlin trusses, generally spaced 18 feet 9 inches apart, support wooden rafters and diagonal roof sheathing. While the purlin trusses were built with split rings and bolts at the various joists, the typical 3-hinged arch joints consist of two ⅜-in. steel plates to which are fastened 12 by 12-in. timbers. Compression as well as tensile stresses are transferred from the timbers to the steel plates by means of 4-in. flush type malleable iron shear plates and ⅞-in bolts. The top and bottom hinges were built of steel pins, side gusset plates and built-in T sections of steel, the latter taking compression forces in direct bearing on the wood while the gussets are to resist tensile forces caused by wind loads.

While the large compressive forces are transmitted through the concrete, the steel plates resist small tensile forces. The ends of the timbers were painted with creosote and saw-cut in the center for a length of 12 in. to minimize checking effects. In the fabrication of the arches the steel plates were used as templates to drill the bolt holes.

Barrett and Hilp were the general contractors and Western Timber Structures, Inc. furnished the split rings and shear plates. The structural design was prepared under the direction of John J. Gould, Chief Structural Engineer of the Exposition.

NORTH ATLANTIC HIGHWAY OFFICIALS TO MEET IN NEW YORK.—The 15th Annual Convention of the Association of Highway Officials of the North Atlantic States will be held Feb. 15, 16 and 17, with headquarters at the Hotel Pennsylvania, New York City. There will be an exhibit of the highway industry in connection with the convention. A. Lee Grover, Trenton, N. J., is secretary-treasurer of the Association.

HIGHWAY FREIGHT TRANSPORT LOAD LIMITATIONS

Feature of Successful Convention of Western States Highway Officials at Reno, Nevada

DISCUSSION from the floor of interest to all delegates attending the Seventeenth Annual Convention of the Western Association of State Highway Officials was one of the main characteristics of the Reno, Nevada, assemblage, Aug. 10 to 13. The highway transport problem was, perhaps, the most important phase of the discussions, however, the question of the coordination of right-of-way practices brought out many variable and troublesome problems. According to Mr. C. F. Seifred, state highway superintendent of Wyoming, too much consideration seemed to be given to the cow.

Under the head of "Channelizing Traffic and Channel Lighting of Highways," Mr. Guy Kelcey of the Signal Service Corporation gave a blackboard discussion of methods of handling traffic flow at intersections, that suggested many variable ways of controlling traffic. The theme of his discussion was to make all control devices as simple as possible. He stressed the point that "It must be simple."

Dr. L. T. Hewes, Deputy Chief Engineer U. S. Bureau of Public Roads, under title "Report of Progress," discussed the results of the highway planning surveys as applied to the Western region. He cited the growth of traffic and its characteristics as compared with the United States in general. From the financial point of view it was quite clearly shown that fiscal policies need revision and attention. While Dr. Hewes merely indicated this need, the statistics and data were so drawn as to clearly demonstrate that insufficient revenues are reaching into highway construction.

The conference realized that safety practices need to be enlarged and coordinated. Discussion from the floor brought out the variation in methods of highway safety promotion. It was indicated by the trend of reports by states that enforcement by highway patrol officers is entirely inadequate, thus requiring considerable more attention to signing and construction practices. Effective accident reduction has been accomplished by the Nevada State Highway Department through its educational efforts. One point of interest that developed from the discussions showed the need for uniformity in signing and safety practices, viz., a large proportion of accidents in any one state occurs to the "foreign" car.

Mr. C. M. Upham, Engineer-Director American Road Builders' Association, discussed the "Continued Highway Program." He explained the slender thread that now holds the highway program as regards federal aid. His talk showed that coordinated educational work is necessary to insure future federal aid and a continued highway program.

As host to the convention, Nevada did a noteworthy job. Interest was intent and expression of opinion, free. The spirit of Western friendliness and cordiality made everyone feel right at home. The ties and bonds of common interest of the eleven Western states and Texas bids fair to making this association a leader in highway thought and practice.

One of the serious problems of the Western states is the overloading of bridges because of the ever-increasing size and weight of motor freight transport units. Besides this, interstate movement of freight hauling units is restricted among the Western states because of the variability of regulations governing width, length, height, load, and axle spacing.

A considerable amount of investigation of proposed load limitations has already been done. It is probable that everyone is familiar with technical Bulletin No. 6 of the Oregon State Highway Department which was published in June, 1937, covering the effect of heavy motor transport on highway bridge stresses. This treatise thoroughly covers the matter of actual highway loadings as found in the State of Oregon and recommends the proper load limitations that will conform to the conditions found. Mr. G. S. Paxson, Bridge Engineer of Oregon, further amplified the data and recommendations contained in Bulletin No. 6 in a report to the load limitations committee, dated June 16th, 1938. The Bridge Committee of the American Association of State Highway Officials, of which Mr. A. L. Gemeny is chairman, discussed the question in recent meetings held throughout the United States, and in connection with these meetings a report covering the study of heavy vehicle loads using the highways of California and stresses produced by these loads in bridge structures was prepared. This report shows graphically and by tables the axle spacing and loads for the various types of vehicles found in California. In connection with the studies being carried on by the bridge committee, Mr. J. R. Burkey, Bridge Engineer of Ohio, prepared a paper which thoroughly discusses this problem based on conditions found in Ohio.

The question of determining proper permissible loads and limiting dimensions for motor vehicles, involves a consideration of economic and practical factors affecting both the equipment itself and the highways upon which it travels. Resolution No. 8 of the Western Association of State Highway Officials states that this question has become acute and it is apparent that some uniform regulations should be adopted—at least in sections having the same general interests such as the Western states. There is, at the present time, a great variety in the restrictions imposed by each of the individual states, although inter-state haul is apparently common and of economic importance to the general public. There appears to be no good reason why a carrier on crossing a state line should be required to make a radical change in his loads or type of equipment used for economical hauling.

INFORMATION ON STATES OTHER THAN CALIFORNIA, TAKEN FROM HIGHWAY USER SERIES LI-A, 1938 ED.

ELEVEN WESTERN STATES & TEXAS
LEGAL VEHICLE WEIGHTS
(IN 1000 Lbs)

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
BRIDGE DEPARTMENT
INVESTIGATION SECTION

APPROXIMATE MINIMUM, AVERAGE & MAXIMUM SPACING. PERCENTAGE ON EACH AXLE. CALIFORNIA RECORDS FOR VEHICLE TYPES SHOWN.	TYPE LOAD	W(L + 40) C =750	W(L + 40) C =800	ARIZ.	CALIF.	COLO.	IDAHO.	MONT.	NEV.	N.M.	ORE.	TEX.	UTAH.	WASH.	WYO.
	AXLE LOAD			18	17 18	18	18	16.8	NR	18	16 17	NR	18	18	18
12.5 / 18.5 / 22.5 (BUSSES) 32.2% 67.8%	2.	39.5 44 47	⑤	22 22 22	26 26 26.3	24 24 24	22 28 28	24 24 24	25 25 25	31.5 35 36	34 34 34	7 14	36 36 36	24 24 24	31.5 35 36
12.5 / 13.5 / 14.5 / 10.0 / 13.5 / 17.5 (11.5% 21.7% 41.8% 78.3% 46.7% -)	251.	47 50.5 54	⑤	40 40 40	43 43 43	43.5 47 50.5	40 43 43	40.8 40.8 40.8	38 38 38	37.5 40 43	43.5 47 49 ≠	7 14	43.5 47 50.5	43 43 43	37.5 40 43
12.0 / 13.0 / 16.0 / 9.0 / 13.5 / 20.0 / 3.5 / 3.5 / 3.5 (11.3% 35.0% 26.8% 26.7%)	252.	49.5 52.5 59.5	51.5 56 63.5	44 44 44	52 52 52	45 49 52.5	44 56 -	40.8 40.8 40.8	38 38 38	39 42 48	45 49 49 ≠	7 14	45 49 55.5	49.5 50 50	39 42 48
0 / 3.5 / 0 (MAX. 4.5°)	DUAL AXLES	32.5	⑥	22°	26°	24°	22	16.8°	25°	26	30.5°	NR	30.5	28 26°	26
12.5 / 15.5 / 19.0 / 3.5 / 3.5 / 3.5 (20.9% 45.0% 34.1%)	3.	42 44.5 47	⑥	34 34 34	34 34 34	34 34 34	42 42 42	34 34 34	38 38 38	33.5 35.5 37.5	39 41.5 44	7 14	39 41.5 44	34 34 34	33.5 35.5 37.5
12.5 / 14.5 / 17.5 / 3.8 / 3.8 / 3.8 / 9.0 / 13.0 / 17.5 / 3.7 / 3.7 / 3.7 (12.6% 26.1% 17.3% 22.0% 21.8%)	352.	52 56 62	55 60 66	56 56 56	60 60 60	48.5 52.5 - -	60 - -	50.8 50.8 50.8	38 38 38	41.5 45 48 ≠	48.5 49 ≠ -	7 14	48.5 52.5 57.5	52 56 60	41.5 45 48 ≠
14.0 / 17.0 / 19.5 / 3.8 / 3.8 / 3.8 / 9.0 / 12.0 / 15.5 / 8.0 / 10.0 / 12.5 / 3.7 / 3.7 / 3.7 (12.0% 23.4% 15.0% 16.3% 16.3% 16.9%)	3-3.	59 65 71.5	63 69 76	68 68 68	68 68 68	63 63 -	56 56 56	68 68 68	76 76 76	47 48 ≠ 48 ≠	55 59.5% - -	7 14	55 60.5 66.5	59 65 68	47 48 ≠ -
						②				①	②	④	②	③	①

* RESTRICTION APPLIES TO TWO AXLE SEMI-TRAILERS ONLY. ≠ MAXIMUM AS RESTRICTED BY MAXIMUM LENGTH AND GROSS WEIGHT FORMULA.

① 600(L + 40) ② 700(L + 40) ③ 750(L + 40) WITH MAXIMUM LOADS.

⑤ ON THE BASIS OF A MAX. AXLE LOAD OF 18,000 ≠, THE PRACTICABLE MAX. GROSS WEIGHT OF ORDINARY TYPE 2 VEHICLE WILL BE AROUND 27,000 ≠ AND OF THE TYPE 251 24,000≠ ON TRACTOR - 18,000≠ ON REAR AXLE OR TOTAL OF 42,000≠.

④ CARRYING CAPACITY ONLY.

⑥ ON THE BASIS THAT MAX. LOAD ON DUAL AXLES CANNOT EXCEED 28,000 ≠, THE PRACTICABLE MAX. GROSS WEIGHT OF THE TYPE 3 VEHICLE WILL BE AROUND 35,000 ≠.

Tabulation Showing Effect of Constant in Formula on Truck Loadings

Load Lengths, Widths, and Heights.—If there is any definite trend in motor vehicle legislation which can be observed at the present time, it is toward a reduction of long and multiple vehicle units. It is noted from the reports prepared by the Highway Users Conference that between 1933 and 1937, four states eliminated full trailers, five states reduced to one drawn vehicle and sixteen states reduced the total length of vehicle combinations from a range of 65 ft. to 85 ft. down to a range of 40 ft. to 50 ft. Only two states made slight increases to 60 ft. and 40 ft. respectively during this period of time.

A general summary of the conditions with regard to the number of vehicles permitted and the total length of combinations throughout the United States is as follows:

Ten states prohibit full trainers and 16 other states permit but one drawn vehicle, whether trailer or semi-trailer. Of the remaining 22 states, 9 permit a maximum length of 45 ft. or less, leaving only 13 states where it is practicable to operate a 3-vehicle combination. Of the 13 states, 8 allow no greater load for the additional semi-trailer over that allowed for the truck and trailer load, and also 4 of these states have a maximum length restriction of 50 ft. The 5 remaining states, where the 3-unit combinations can be effectively operated, are Arizona, Idaho, Montana, Nevada and Ohio, all but one of them being in the Western group of states.

In California, it is found that relatively very few vehicle combinations exceed 50 ft. in length although that state permits a maximum length of 60 ft. However, due to the fact that there are large areas in the state not served by any railroad and it is often necessary to haul long poles, steel girders and other long pieces by truck, it is believed that the existing maximum should be retained.

Mr. Paxson, in his report of June 16th, covered the question of length of vehicle combinations quite thoroughly and the following is quoted from his report:

"*Length.*—The A.A.S.H.O. recommendation is for a 35-foot overall length for single vehicles, a limitation of the combination of vehicles to not more than two units, and a gross length of 45 feet. It further provides that a truck tractor and semi-trailer be considered as one vehicle in determining length thus limiting this type to 35 feet, but permitting the semi-trailer to draw another trailer. In the eleven western states the maximum legal lengh of combinations varies from 45 feet in New Mexico and Wyoming to 85 feet in Arizona; the semi-trailer length varies from 35 feet in Idaho and Oregon to 85 feet in Arizona; and the length of single units varies from 33 feet in Arizona and California to 60 feet in Nevada. Here again the western states are more liberal than the mid-western or eastern states. Only 15 states in the United States permit lengths greater than 60 feet, seven of these are western states. The roadway widths required for 50 and 60 foot combinations are shown on pages 28 to 35 of Bulletin No. 6. You will note that even 50-foot combinations cannot stay on the surfacing when passing and 60-foot combinations swing so far over that a definitely dangerous condition is created. The highway departments are the parties responsible for highway

design and operation and we should not recommend a thing which is hazardous to the highway user. Since so many of the highways in the western states are in mountainous country requiring heavy curvature, it would seem that 50-foot lengths are all that should be allowed except by special permit for exceptional movements. A proposal to increase the length to 60 feet was presented to the last session of the Oregon legislature and unanimously rejected by the legislative committee. The motorist does not like to meet or pass these long truck trains.

"Paragraph (c) of Section 3 of the A.A.S.H.O. code provides that for the purpose of determining length truck tractors and semi-trailers shall be construed to be one vehicle. Only Idaho and Oregon, of the western states, have written this provision into their laws. Colorado allows 40 feet for a semi-trailer and 50 feet for other combinations. The other western states treat semi-trailers the same as other vehicular trains. I am attaching hereto blue prints showing semi-trailers on 28 degree and 56 degree curves. The spacing of axles materially affects the roadway required but, in general, these prints show the worst practical arrangements. A comparison of these prints with Figures 9 to 16 of Bulletin No. 6 shows that semi-trailers require very little, if any, more roadway than truck and trailer trains. It would seem that paragraph (c) should be eliminated and semi-trailers placed on a parity with truck trains."

With regard to the width of vehicles, 8 ft. appears to be standard throughout the Western states except for certain special exemptions which allow a few inches additional for vehicles originally constructed with solid tires which have been changed over to pneumatic. As a matter of fact, in the entire United States, only Connecticut and Rhode Island permit a width greater than 8 ft.; and two states, South Carolina and Florida, restrict the width to less than 8 ft. It is to be remembered at this time that the U. S. Bureau of Public Roads and the various state highway departments have found it advisable to recommend an additional 1 ft. width of lane in constructing state highway pavements in order to take care of the existing conditions. Inasmuch as it will be many years before existing roads can be widened to safely take care of even the existing widths of heavy vehicles, it is believed that the width should be kept to a minimum consistent with a reasonable maximum for trucks now operating on the highways.

A wide variation exists in the Western states with regard to the permissible height of vehicles, which ranges from 14.5 ft. in Arizona and Montana down to 11 ft. in Oregon. The U. S. Bureau of Public Roads requires a minimum of 14 ft. for structures built on federal aid highways and this height is likewise the minimum required by the California Railroad Commission in the case of grade separation structures. In the entire United States, only 13 states allow heights greater than 12.5 ft. and 6 of these states are in the Western group. The suggestion has been made by representatives of Washington and Oregon that a uniform limitation of 12.5 ft. should be adopted, reserving to the states the right to grant "over-height" permits for special loads on sections of highways where such heights can pass. California does not favor such a procedure and would prefer to maintain their present clause which permits a height of 13.5 ft. with the power to restrict the loads on roads that do not have sufficient clearance to handle this height. It is again to be remembered that many of the states have underpasses and through truss bridges constructed many years ago in which the vertical clearance is much less than allowed by the laws of the state itself and, of course, all other states which permit equal or greater clearances.

INTERNATIONAL ROAD EXPOSITION AT SANTIAGO, CHILI

The organizing committee of the Third Pan-American Road Congress, which will be held in Santiago, Chili, in January, 1939, has decided in accordance and with the financial support of the government of Chili, to hold an international road exposition.

The Chilean Department of Foreign Relations is sending a circular to all its embassies, legations and consulates in the great industrial countries, to request their help before the respective governments and the industrialists themselves in favor of the success of this exposition, to which it desires to give the widest scope possible.

It is expected that the congress and exposition will be attended by many important groups of engineers. Communications may be addressed to Engineer, Roberto, Torretti, Commissioner General, Santiago, Chili. It is presumed also that local Chilean representatives can supply information.

▼

AMERICAN INSTITUTE OF STEEL CONSTRUCTION MEETS IN OCTOBER

The 16th annual convention of the American Institute of Steel Construction will be held Oct. 11, 12, 13 and 14 at French Lick Springs Hotel, Frenck Lick, Ind. Invitations have been mailed to some 1,700 executives of the structural steel fabricating shops of the United States and Canada, and advance interest indicates that the attendance will be larger than normal.

One of the features of this convention will be an appraisal of the future possibilities of steel construction that will be participated in by some of the leading experts on this subject. The speakers will include Dr. Willard Thorp of Dun & Bradstreet; Mr. Lowell J. Chawner, Chief, Division of Economic Research, U. S. Department of Commerce; Dr. Miller McClintock, Director, Yale University, Bureau for Street Traffic Research; Mr. Victor J. Brown, Publishing Director, Gillette Publishing Company.

Dr. Gus W. Dyer, Professor of Economics, Vanderbilt University, Tennessee, will address the banquet which is to be held on Oct. 13.

Many other special events have been arranged and will be announced later when the full roster of speakers has been selected.

▼

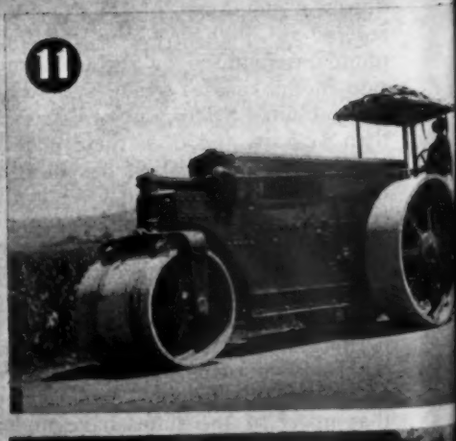
North Carolina's Master Planning Map

More than 59,000 miles of state roads are shown on North Carolina's largest map, constructed by the statewide planning survey. The map, 16 feet long and 6 feet high, also shows every church, school and railroad line in North Carolina. It is built by pasting together maps of the 100 counties.

The planning survey is a long-range attempt to cope with modern highway and traffic problems. One division works solely on the problem of grade crossings, of which there are around 3,000 in the state. Highway counts to determine the flow and volume of traffic are also being made.

Complete now is the work of checking weights, destinations and cargoes of trucks on the state highways. One aim of the survey is a mathematical denominator which will immediately indicate how much money per year must be expended to take care of wear and tear of any given type of road under any given traffic condition.

U. S. A. EQUIPMENT BUILDS MEXICAN ROADS



MEXICAN NOTES AND SCENES

By NAN S. POWERS

Publishing Director of Powers' Road and Street Catalog

THE pictures at the left were secured while on my trip to Mexico this summer. During this visit it was my pleasure to meet and discuss highway problems with Sr. Ing. Jorge F. Galvez, Sub-Director; Sr. Ing. Eduardo R. Moya, Chief, Machinery Division; Sr. Wenseslas Quintana, Zone Supt. of Machinery; Sr. Rafael Flores, Zone Supt. of Machinery, and other officials of the Mexican National Highways. It was through the courtesy of these gentlemen that the accompanying views of work in progress were obtained.

Other interesting pictures are omitted for lack of space.

The pictures shown are as follows:

1. Universal Crushing and Screening Outfit. Stopped at Tuxpan while moving between locations.

2. Etnyre Distributor on the Mexico-Guadalajara Road—Elevation 9,000 ft.

3. Water Boy on the Tepetlispa Job—Not all U. S. A. equipment.

4. Jaeger Model MP-2 Mix-in-Place Road Builder on Guadalajara Road.

5. The Church, Capilla del Sacro Monte, faces the main highway through Amecameca. Mrs. Mortimer (right), wife of Philip W. Mortimer, District Manager of Minneapolis-Moline Power Implement Co., and I stopped to inspect its quaint interior, and on coming out were "snapped" by Senor Quintana.

6. Mixed Bituminous Surface Material placed by Jaeger Road Builder.

7. Caterpillar Diesel and Caterpillar Grader Preparing Base on Mexico-Morelia Road.

8. Etnyre Distributor Applying Final Coat of Emulsion on Mexico-Morelia Road.

9. Caterpillar Diesel Patrol Grader between Jobs on the Mexico-Puebla Road.

10. Northwest Shovel Ready to Begin Culvert Excavation on Mexico-Guadalajara Road.

11. Buffalo-Springfield Roller Consolidating the First Gravel Coat on Amecameca Road.

12. Buffalo-Springfield Working on Base through the Indian Town of Tepetlispa.

13. Truck Supplying Asphalt to the Jaeger Machine on Guadalajara Road.

14. Caterpillar Tractor and Grader on Base Construction—Mexico-Morelia Road.

I found the Mexicans to be distinctly road minded, and was informed that the sentiment is growing rapidly. In spite of some fine major highways, however, the need of both major and secondary roads is conspicuous, and it is clear that republic has a long construction period ahead. As to methods, there is little difference from the United States except for a slower tempo of labor—this, of course, in reference to such operations as paving and major grading. In the back country more primitive means are still used in building roads for local needs.

An interesting resurfacing job was in progress between Tepetlispa and Amecameca, where the old road was so badly worn that my chief impression was of bumps and chuck holes and large protruding stones.

Repairs were begun by scraping with the diesel patrol grader. Then the dust was swept off by hand, large native-made brushes being used for the purpose. After the sweeping, asphalt was applied with a power distributor, and a coat of fine screenings was spread by hand. These screenings were produced by the crusher shown in the picture, working at the nearest pit of suitable material. It is interesting to note that the Mexicans refer to screenings as "sand." Careful rolling with a gasoline roller finished the job.

The Mexican Department of Communications and Public Works during the past twelve months has constructed approximately 350 miles of pavement, and has opened a total of about 500 miles of new road, at a cost of almost 23,000,000 pesos—about 4,600,000 U. S. dollars. An average of about 16,000 men has been employed daily on this work.

▼

AMERICAN RECEIVES BELGIAN GOVERNMENT HIGHWAY ENGINEERING AWARD

Lloyd F. Rader

Lloyd F. Rader, associate professor of civil engineering at the Polytechnic Institute of Brooklyn, has just received notification that he has been awarded the Prize of Belgium in a world-wide competition sponsored by the Permanent International Association of Road Congresses which was held at The Hague, Holland, June 20-25, 1938.

The Prize of Belgium, established by the Government of Belgium about ten years ago, is an award of 2,000 francs for the dissertation that contributes most to the advancement of highway engineering. Competition for the prize is held at quadrennial sessions of the congress. It was awarded first to Edwin W. James, Chief, Division of Highway Transport, U. S. Bureau of Public Roads, at the 1930 meeting in Washington, D. C.

The subject of Professor Rader's paper was "Investigations of the Physical Properties of Asphalt Paving Mixtures at Low Temperatures." All of the laboratory work connected with his investigation was conducted in the Highway Materials Testing Laboratory of the Polytechnic Institute.

Dr. Rader graduated from the University of Michigan in 1924, subsequently taking his master's and Doctor's degrees from that institution. He taught civil engineering at the University of Nebraska for three years and has been in charge of highway engineering at the Polytechnic since 1928. He is a member of Sigma Xi, the Institute of Traffic Engineers, the American Society of Civil Engineers and the Association of Asphalt Paving Technologists.

▼

Peru Completes 211-Mile Highway

Peru's longest asphalted highway, from Lima to Inca, a distance of 211 miles, was opened on June 5. Reconstruction of this old Inca road, including widening, straightening, bridge and culvert work, asphalting, placing road signs, etc., was completed in about one year, at a cost of $1,720,000. It constitutes a section of the Pan-American highway, and affords the nation's first high-speed touring on a smooth, comfortable surface over a long distance.

OBSERVATIONS BY THE WAY

By
A. PUDDLE JUMPER

¶ In discussing right-of-way problems Mr. Seifred, Wyoming State Highway Superintendent, told about the day his office was besieged by calls from the radio studios. It seems that one of his maintenance crews were blasting along the highway. He went out to see what the trouble was and asked the foreman if he broke any wires. Seifred explained the dilemma of the radio men to the foreman whose reply was, "Why should they be so worked up about one little wire? There are 26 others on that pole."

• •

¶ Chas. D. Vail, State Highway Engineer of Colorado, was elected president, and Geo. T. McCoy, Assistant State Highway Engineer of California, was elected secretary of the Western Association of State Highway Officials. They've got a big job on their hands to keep up with the dynamic results of Murrow and Allen, Washington and Nevada, State Highway Engineers, respectively, past president and past secretary.

• •

¶ Nevada, I believe, is the only state in the Union to have a district engineer at large.

• •

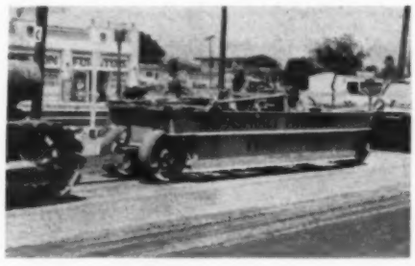
¶ Mr. L. A. Hague, Montana State Highway Commission Chairman, suggests reflecting signs be devised to mount on heads of range cattle as protection to travelling public. It seems that range cattle like to bed down for the night on the state highways.

• •

¶ Mr. Seifred, Wyoming State Highway Superintendent, made plea to convention to have an A placed at beginning of name of his state. He seems always to be confronted with two troubles:

1. Lateness of hour.
2. Previous speakers expounded all of his thoughts.

¶ Planing the bituminous surfaced streets of Alhambra, Calif., is where I noticed this big machine. It appeared to be doing a good job. I'd



think a light seal coat should be spread on the surface after this machine finishes.

• •

¶ The State of Ohio is performing a splendid service for the motoring public by building excellent Roadside Parks in various parts of the State. This one is on U. S. 30N

near Bucyrus, Ohio. Facilities invariably include stoves, tables and benches, comfort stations. They're under the supervision of the Ohio State Highway Patrol.

• •

¶ During the Cal-Neva Lodge banquet, Allen of Nevada, brought out the long and the short of his labors—Egan and Hokum.

• •

¶ If we are to believe the Idaho songbirds at Cal-Neva, they don't give a damn for any other state—it seems they believe in Idaho.

¶ I can't qualify the W.A.S.H.O quartet for radio, good as they were. Wilson (Calif.), Murrow (Washington), Fritts (Washington), and Carpenter (Nat'l Pk. Serv.) are longingly looking for that dear old fashioned girl at Lake Tahoe, Nevada.

• •

¶ When Allen, State Highway Engineer of Nevada, does things, he does them with the force of a battering ram and the completeness of a successful finesse.

• •

¶ What irks me is the apparent utter neglect or lack of consideration of highway commissions for adequate bridges. We do miles per hour over an excellent stretch of highway only to run onto an old, inadequate bridge. The accompanying picture shows just

such a bridge over Putah Creek between Sacramento and San Francisco, Calif., on U. S. 40. Better never change the name of that creek to English. How did that ever get by in California?

• •

¶ Incidentally, just such a condition exists on the east end of U. S. 40, in Maryland; an old hump backed bridge that throws you out of your seat when you strike it.

• •

¶ A man from the PWA in California called up the bridge department the other day and asked if they would design a timber bridge for

PWA to cost not over $5,500. When asked how long the bridge must be, the PWA man said he didn't know. Pretty good, eh?

• •

¶ To my way of thinking Nevada knows how to build some of the smoothest black top roads in this country. I traveled many miles over the smoothest in the U. S.

• •

¶ Senator Pat McCarran, Nevada, says we're in for a fight to maintain federal aid. Wise counsel—he knows. What are *you* going to do about it?

• •

¶ When the Forest Rangers say "Smoking Prohibited," believe me when I say, "They mean it!"

• •

¶ To help the tow tractor load the big grading scrapers a tractor with bulldozer pushes from behind. The accompanying picture shows the device—a hinged block that Hafey-

Moore Co. and Fredrickson-Watson Co., contractor on the Los Gatos-Santa Cruz, Calif., highway job mounted on the rear end of the Le Tourneau scrapers for the bulldozer to push against.

• •

¶ On the Los Gatos-Santa Cruz job I noted the new Emsco power-takeoff mounted on the D-8 Caterpillar pulling a 20-yd. scraper. The foreman said it was a good rig.

• •

¶ I asked a mechanic on the grading job how he liked preformed wire rope. He said it is much better than regular rope. He said they use nothing else, now.

• •

¶ If you get a chance, be sure to see the new brick paving job on U. S. 21, just northwest of Massillon, Ohio.

The design consists of a 3 in. monolithic brick surface course (without cushion) on a 9-7-7-9 in. reinforced concrete base course. There is a 1 in. expansion joint at 60 ft. intervals with a longitudinal center joint. The transverse expansion joint is of the assembled metal type with dowels and bituminous premolded filler with a cork extension in the brick surface. This joint is continuous from the bottom of the base to the top of the surface. The longitudinal center joint consists of premolded material which extends 2½ in. in the concrete base and has a total depth of 5½ in.

A striking feature of the job is that construction is mechanized to a large extent. Elmer O. Vogt is the contractor.

• •

¶ The contractor on the Los Gatos-Santa Cruz road builds his culvert form outside and puts it in the struc-

ture. This is the type of form used for culvert inlets. It looks like a scroll case form.

• •

¶ A brake inspection in progress in Akron, Ohio. At a speed of 20 mph, cars were required to stop

within 24.6 ft. All those who couldn't qualify were required to take their cars to a vacant lot adjacent to the inspection spot and couldn't remove them until the brakes were fixed. All who did qualify were given a sticker for their windshields.

• •

¶ When Chairman Frank Dunlap and Chief Engineer W. Vance Baise of the Highway Commission dropped in on the Budget Commission, they also dropped a bombshell to the tune of $39,600,000 worth of work on the state roads (main trunk lines only).

That this much wasn't actually expected was revealed by Chairman Dunlap who commented that he "of course knew the absurdity of asking for $40,000,000."

The idea was, however, not to let the chance go by without informing these adjusters of appropriations just what the highways of that state did need to get into tip-top shape.

• •

¶ Signs of the times: intersection of U. S. 2, 6, and 20, Cleveland, Ohio.

• •

¶ Nixon Denton, sports editor of the Cincinnati *Times-Star*, goes poetic amidst the quiet, serene surroundings of a WPA road job. The road is in Mt. Washington, a suburb of Cincinnati. His soliloquy appeared in his column "Second Thoughts." By his description of the job we infer he could have published the poem in a column on "Unfinished Thoughts."

When Cheops built his pyramids,
The critics down below
Watched monolith top monolith
And said, "Good God, he's slow."

It took the Pharaohs three decades
To do the job, they say,
But it would have taken longer
With the WPA

Four years ago, on Salem Road,
Held up by pick and spade,
The workers started leaning
Through a quarter-mile of glade.

They picked up chunks of limestone
And piled them in a stack,
And then, when they were rested,
They put the limestone back.

They moved the roadbed north and south,
They moved it east and west;
They raised it up and put it down
To see which way was best.

Then, shutting off all traffic,
From Bethel to the sea,
They almost changed the highway
To the way it used to be.

Orchids, then, to Cheops,
Slow builder of the past;
He may have taken thirty years,
But he got her done at last.

INTERESTING AUTOMOTIVE DATE

Boston (1898)—With an "automobile steam fire engine" in regular service, this city is priding itself on its advanced stand in relation to use of the automobile for municipal purposes.

American Road

WASHINGTON, D. C.

VAIL ELECTED PRESIDENT BY

Down the Road

By CHARLES M. UPHAM

Engineer-Director,
American Road Builders' Association, Washington, D. C.

GERMANY'S SUPER-HIGHWAY SYSTEM

When the average American thinks of Central Europe, he usually thinks also of dictators, rearmament and war. Germany, in particular, is looked upon as a danger spot which may at any moment ignite another world conflict. All German activities, therefore, are studied for possible military significance. So, when Germany began its huge road-building program, which has resulted in a system of super-highways second to none, that activity was construed by many to be strictly a military project.

As a representative of the United States government to the recent International Road Congress at The Hague, I had the opportunity to travel over 3,000 miles of German highways, of which nearly 800 miles were part of the new Reich autobahn system. Whether or not it be true that these roads were constructed primarily for military purposes, it is most certainly true that they provide the German people with innumerable peacetime commercial, industrial, social and cultural benefits. Although these roads may some day be used to speed the movement of mechanized agents of death and destruction, they are at present responsible for an 83 per cent reduction in the number of traffic accidents.

Built into the German super-highways are most of the safety features that have long been recommended by American highway engineers. The new roads consist of two double-lane highways, each 25 feet wide, with opposing streams of traffic completely separated. Beyond these traffic lanes are adequate shoulders and a gradual slope to a drainage system. Railroad grade crossings and highway grade crossings have been completely eliminated with a majority of the intersecting roads being carried over the right-of-way of the new system by a most modern type of overpass construction. All curves are super-elevated and the surface finish of the pavement is non-skid. Traffic is controlled at road junctions by a clearly defined and systematic layout and parking places are provided at carefully chosen intersections. Pedestrians, bicyclists and animals are excluded from the highways and no advertisements or billboards can be erected by the roadside. Efforts are being made to retain and to enhance the beauty of the landscape.

There is no speed limit in Germany. The roads are designed for speeds from 80 to 100 miles per hour, according to the topography of the country. It is claimed that there have been no major accidents on the autobahn system chargeable to the condition of the road or to detail of design. This record is particularly remarkable when compared with the situation in the United States. Of the 40,000 traffic accident fatalities in this country last year, it is estimated that at least 50 per cent can be blamed on the failure of the roads to meet the demands of modern traffic.

While conditions in our country do not demand or justify the immediate construction of a complete super-highway system like that in Germany, there are areas where heavy traffic and numerous accidents do call for the construction of roads of this type. A system of American super-highways could not be constructed in a few years but could be designed, laid out and some sections constructed in locations where traffic is heavy and congested and a super-road is particularly needed. If this policy is followed, superhighways can be constructed when the need arises and this country will, in the futare—possibly ten, twenty or even forty years from now—be provided with a system of highways that will adequately and economically care for the increased traffic demands that are bound to come.

VAIL ELECTED PRESIDENT BY WESTERN HIGHWAY OFFICIALS

Charles D. Vail, state highway engineer of Colorado and a director of the American Road Builders' Association, was unanimously elected to the presidency of the Western Association of State Highway Officials at the group's seventeenth annual convention in Reno, Nev., August 10 to 13. He succeeds Lacey V. Murrow, director of highways in the state of Washington.

WESTERN OFFICIALS WANT ARBA IN SAN FRANCISCO

Whereas, The American Road Builders' Association, whose membership comprises representation of the highway industry and highway profession, has been an influencing factor in the construction of an adequate highway program; and

Whereas, The American Road Builders' Association each year holds a national convention and highway exhibit; and

Whereas, The American Road Builders' Association has not in recent years held its convention and exhibit in the West, and

Whereas, It has been demonstrated that the highway program is the result of co-operative action of those interested in the industry and the profession;

Now, Therefore, Be It Resolved, That the Western Association of State Highway Officials, in convention assembled at Reno, Nevada, extends its co-operation to the American Road Builders' Association and urges that it hold its next convention and exhibit in San Francisco, California; that the individual states take an active part in the convention sessions, and that the equipment and material manufacturers display their latest developed products in order that the industry and profession may become acquainted with these products.

UNIVERSITY OF MICHIGAN HONORS CHARLES UPHAM

A picture of Charles M. Upham, engineer-director of the American Road Builders' Association, will be hung in the Transportation Library of the University of Michigan at Ann Arbor. Mr. Upham and other outstanding American highway engineers have been selected for this honor because they are considered the men primarily responsible for the highway development in the United States for the past twenty-five years.

Builders' Review

SEPTEMBER, 1938

JULY'S LIST OF DEAD

Over the past five years, July's list of dead from accidental causes has been 29 per cent greater than that of the average month.

WESTERN HIGHWAY OFFICIALS

With Our State Groups

ALABAMA

Alabama citizens will vote on a constitutional amendment to outlaw diversion at the general election on November 8. This amendment, which was sponsored by the Alabama Road Builders' Association and other highway-minded groups, was presented and passed during the last special session of the legislature. Alex. C. Montgomery of Birmingham, vice-president of the Alabama Motorists' Association, is directing an active campaign to insure its passage. Committees of highway users are being organized in every county to aid in this work. Mr. Montgomery is seeking to co-ordinate the activities of all other citizen and taxpayer groups interested in prohibiting diversion.

FLORIDA

"Highway Highlights," a ten-page bulletin of highway news, is being published by the Florida Section of the American Road Builders' Association under the direction of H. M. Birtley, secretary.

ILLINOIS

The Illinois Road Builders' Association celebrated its first birthday on August 17. During the year that has passed since its formation, membership in this group has increased from 24 to 170. Taylor G. Soper was last month added to the IRBA staff as assistant to the executive secretary, Ralph W. Ibenfelt, to aid in bringing about an even further increase in this membership. The association is formulating plans for a full program of work during the coming year.

MICHIGAN

Plans for an educational campaign to bring about passage of a constitutional amendment prohibiting diversion of highway money to non-highway purposes were formulated by the Michigan Good Roads Federation at a meeting on August 16. The meeting was held at the Saginaw Country Club, where directors of the federation were guests of F. N. Andersen, president of the Andersen Sand & Gravel Co. All organizations interested in the highway program will be invited to assist in the campaign.

The new Middletown-Portland bridge, the largest span in New England, was dedicated and opened by Governor Wilbur L. Cross of Connecticut on August 9. Under construction for the past two years, this bridge was built at a total cost of $3,458,629. The total length, including all elevated roadway, is 3,420 feet and the capacity is 5,000 vehicles per hour. Bonds to build the structure were raised in Middlesex County and financing has been arranged to amortize these bonds out of state funds, so that collection of toll from users of the bridge will not be necessary. Approximately 100,000 people took part in the dedication ceremonies in Middletown which were preceded by a parade and climaxed by a fireworks display.

TEXAS

The Texas Good Roads Association will have an exhibit at the Texas State Fair at Dallas, October 8-22, co-operated in by the state highway department and the state public safety commission. Highway finance, engineering, construction and safety will be stressed in an effort to interest visitors to the fair in the highway program and its problems. Displays designed to stimulate travel to the points of beauty and interest in the state will also be included. October 14 will be Texas Good Roads Day at the fair and on that day there will be an extensive program participated in by state officials and the directors of the Texas Good Roads Association, who will hold their semi-annual meeting at this time.

SOIL STABILIZATION

After Texas State Highway Department's Procedure and Results

A SHORT COURSE

Based on Tests for Securing Satisfactory Base Materials

By FRANK H. NEWMAN, JR.
Binder Research Engineer,
Texas Highway Testing Laboratory

PART V

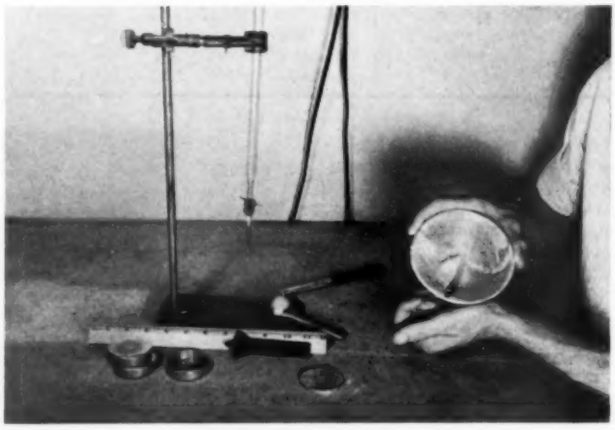
THE State of Texas contains a large mileage of highways for its population, which means that the gasoline tax dollar must build as much roadway as possible. Fortunately, much of the state is blest with some type of native material that can be used for road-building purposes, such as gravel, rock, caliche, shell, and iron ore top soil. The normal construction consists of using these materials as a base over which is placed an impervious wearing surface. It is unfortunate, but true, that much of the native material of each of the various types will not make a satisfactory base under an impervious top. In many cases the materials in two deposits will have the same appearance and texture, yet one will make an excellent road, whereas the other will fail. It is therefore necessary to have some reasonably reliable means of testing these materials and determining their suitability before they are subjected to the rather expensive test of trial by use.

The Page tests of cementing value and slaking time were formerly used for evaluating the quality of base materials, but have proved inadequate for the purpose. These tests were developed during the days of open-surface macadam roads and horse-drawn wagons, where the binder which washed and blew out from between the stones was constantly being replaced by new binder created from the grinding action of the horse hoofs and iron wheels. One of the engineer's chief concerns was whether this new binder would adequately "set up" and hold the stones together during dry weather and these tests were designed to furnish this information.

Grain Size Divisions and Behavior

The term "soil binder," which will be used quite frequently throughout the remainder of this article, is defined as the sum total of all particles in a base material or soil mixture that are smaller than 40-mesh in size. Regardless of whether a soil binder is taken from gravel, caliche, iron ore top soil, or crushed rock, it can be given the same tests as one used for any soil, and a study of the soil constants obtained will reveal the probable behavior of the material in a roadway.

Washing Out the Soil Binder



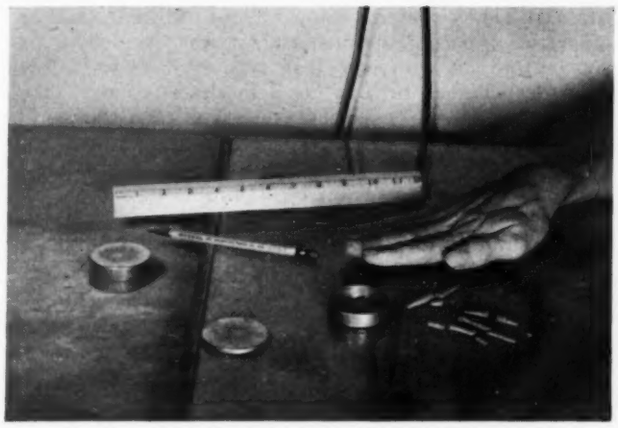
Liquid Limit Test—Hand Method

The functions and characteristics of the several parts of a soil or soil binder have previously been described in detail[1], but a brief review at this point will aid in showing what the soil constants actually measure in a flexible base material. All soils are divided *by size* into three principal parts, namely, sand, silt and clay sizes. In different soils the soil particles may be derived from different sources, but the particles which fall in the same size group will have certain similar characteristics.

The fine sand group consists of all particles passing the No. 40 sieve and retained on the No. 270 sieve (0.05 mm.), and these particles may be considered as inert in their physical reaction with water. Capillary or gravitational water may enter and fill the pores in the particles themselves, and all or part of the voids between the particles, but there is no tendency for the individual particles to separate from one another.

By silt is meant all particles finer than the No. 270 (0.05 mm.) sieve and larger than 0.005 mm. in diameter and these particles may likewise be considered as inert. Their physical properties when in contact with water

[1] "A Short Course in Soil Stabilization"—ROADS AND STREETS, Feb., 1938.



Plastic Limit Test

are much the same as for sand except that the individual grains, and therefore the voids between the grains, are much smaller in size. This means that a column of silt can usually take up more water, and lift it higher by capillary action, than a corresponding column of sand.

All particles smaller than 0.005 mm. in diameter constitute the clay sizes, and all clay particles smaller than 0.001 mm. in diameter, are known as colloids. The clay particles are the active constituents of a soil binder mixture and most of this activity is furnished by the colloids. If a column of clay is exposed to capillary or gravitational water, not only will the voids between the particles be filled, but each of the clay grains will tend to adsorb a film of water around itself and thereby separate from its neighbor. This causes the total soil mass to increase in volume and become plastic with the addition of moisture and to decrease in size when the moisture is lost. Some clays are more active than others; therefore, the maximum size of this film will depend upon the character of the clay particle involved. A clay grain that is part of a soil mixture, however, will seldom be able to adsorb the maximum thickness of water film of which it is capable, due principally to two factors: (1) the loss of moisture caused by evaporation from some connecting surface of the soil mass, and (2) confinement due to internal compaction or external pressure. When this adsorbed film is much thinner than its normal capacity, the surface is more viscous than ordinary water, and the clay grain becomes a strong binding medium instead of a lubricant.

A good type of soil binder mixture will contain enough sand and silt grains to assure stability in the mass when wet and enough clay grains to furnish cohesion to the mass when damp or dry. If there are not enough active clay particles to coat the surface of the inert sand and silt particles fairly well, the mixture will lack cohesion and be extremely difficult to set up in road construction. If on the other hand there is an overabundance of active clay particles in a soil mixture, these particles will adsorb enough water to slide on each other and thus act as a lubricant instead of a binder between the sand and silt particles. This soil binder will then in turn act as a lubricant between the other aggregates in a base material and result in a base which is unstable under traffic.

This means that the majority of base failures are caused by an excess amount of active clay particles in the soil binder mixture. A base material cannot be judged by a determination of the amount of clay particles present, however, because different clays will vary greatly in activity; also, the activity of the soil binder mixture will be affected somewhat by the size, shape, and grading of the sand and silt particles.

Soil Constants

What is needed, then, is some test or tests that will determine the activity of the total soil binder mixture. There is an even greater need for a test which can be used by the field engineer to control the quality of a base material produced at the pit each day during construction. The soil constants, which are the standard tests made on subgrade soils, will answer both of these needs. The Texas State Highway Testing Laboratory normally reports a total of seven soil constants, but we have found that the quality of a base material can be judged by the percentage of soil binder and three of the soil constants, namely, the *Liquid Limit, Plasticity Index*, and *Linear Shrinkage*. Since these are the tests now being used to control the quality of material in the field laboratories, we shall limit our remarks to a discussion of these three constants.

Water is the medium which changes the behavior of any given soil or soil binder; therefore, each one of the soil constants, except the linear shrinkage, is expressed as the per cent of water, by weight of oven-dry soil, that is necessary to bring the soil to a certain consistency. Let us visualize for a moment an air-dried clod of soil which will probably contain a small per cent of moisture but is definitely in a solid state. Any attempt to change the shape of this clod will merely break it into smaller pieces.

If it were possible to gradually add water uniformly throughout the clod, it would finally reach a condition wherein the shape could be changed by manipiulation without breaking it apart. The soil is then said to be in a plastic state, and the percentage of water present at the transition from the solid to the plastic state is called the *Plastic Limit* of the soil. The end-point used for making this test consists of rolling the soil between the palm of the hand and a glass plate until it begins to break up in threads about ⅛ inch in diameter.

If we continue to add water to this damp soil, it will become more and more plastic, i.e., its shape can be changed with less pressure. Finally, a condition is reached where only a jarring action is needed to cause the soil mass to flow. The soil is now said to be in a liquid state, and the lowest per cent of water that will produce this state is called the *Liquid Limit*. In making this test a groove is cut through the material in the evaporating dish and the end-point is reached when the

Linear Shrinkage Test—Bar Method

groove will close under ten standard blows against the heel of the hand.

The *Plasticity Index*, or plastic range, of the soil is then calculated as the numerical difference between the plastic limit and the liquid limit. This test measures the resultant activity of the soil binder mixture, with the more active soils showng higher plasticity index values. A fairly clean sand, or granular material with few clay particles, will show a very low plasticity index —passing almost directly from the solid state to the liquid state.

The *Linear Shrinkage* test, as it is made by the Texas Highway Department, is the loss in length, expressed as a percentage of the original wet length, incurred by a specimen in shrinkage from the liquid limit state down to dryness. This determination is not exactly the same as that used by the U. S. Bureau of Public Roads but when expressed in this form, the test measures the activity of the soil binder mixture.

In making the linear shrinkage test at the Austin Laboratory, a pat dish of known volume is filled with wet soil mixture at the liquid limit consistency. The specimen is first air-dried, then oven-dried, and the dry volume measured by displacing mercury. The percentage of volumetric shrinkage, on the basis of original wet volume, is then calculated and converted to terms of shrinkage in one dimension and expressed as per cent linear shrinkage. Since the equipment necessary for making this test is not available in the field, a ¾ by ¾ by 5-inch bar specimen is formed in a metal mold and the actual loss in length measured by means of a rule, with 1/20 of an inch representing one per cent linear shrinkage.

The above tests are part of a series of tests which were recommended by the Bureau of Public Roads in publication[2] of 1931, to be used for classifying soils into one of eight groups according to their physical behavior. A soils section was added to the Texas State Highway Laboratory in June of that year and these soil constants obtained as routine tests on subgrade soils.

Application of Constants to Base Materials

Several years ago a research section was created for the purpose of finding some test that would distinguish between good and bad base materials. One of the first tests made on these samples was to determine the soil constants of the binder passing the 40-mesh, but several of these samples were classified as "good" behavior yet tested to be definitely poor types of binder. Most of the research work was then devoted to some other type of test.

It was not discovered until later that these roads had only been surfaced a short while and the base material presumed to be good because it had served as an excellent open surface road for many years. After evaporation had been cut off, these roads eventually failed so badly that the majority of the material has been replaced at the present time. This should serve to emphasize the fact that the behavior of a material as an open surface road is no criterion of what its behavior will be when covered with an impervious wearing surface.

Sampling and Testing Procedure

About two years ago it was decided to collect a large number of samples of base material from old roads of known field behavior and determine which of the present tests, if any, were satisfactory for separating good materials from bad. Since there was more caliche in the State of Texas, and less known about testing it, than any other one type of base material, it was decided to first concentrate on sampling this type of roadway. The term "caliche" is broadly used to describe any deposit of material that has a calcareous type of binder. The material is found in some form throughout practically all of Texas, except the extreme eastern portion, and the aggregate varies from hard limestone to very soft friable lumps, or a mixture of both. All base materials with an angular or crushed aggregate were also considered to be in this group.

This work was performed under the direction of the Materials and Tests Engineer, with the aid and cooperation of the field engineers. The majority of these samples were taken by the writer in company with a member of the field division in each case who was familiar with the history and behavior of the road and base material involved.

A great deal of care and attention was paid to the selection of samples and their classification at the time of sampling, because the whole value of the correlation of the various tests was dependent upon the proven field behavior of the sample being definitely known. The materials were classified according to their field behavior into three groups, namely, "Good," "Doubtful," and "Poor." A sample was not taken if the sampling parties could not both agree to classify the material into the same group.

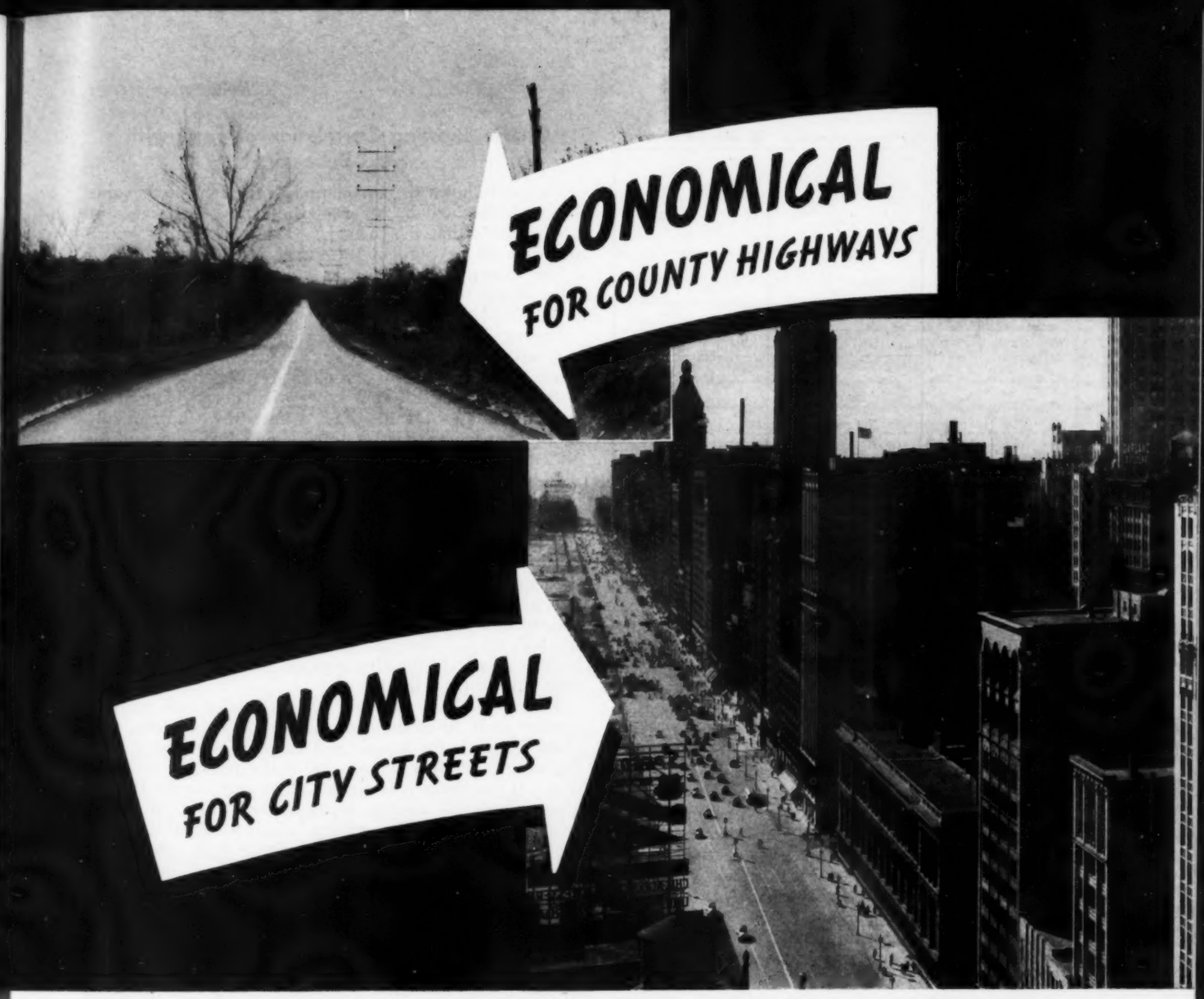
Where a stretch of road from a given pit, which had been topped for two years or more, contained no base failures and still remained smooth for its age, the base material was classified as "Good." A sample was taken at any point of slightly worse than average drainage.

A sample was classified as "Doubtful" for one of several reasons, but each of these roads had been topped more than two years. In some cases there were no definite base failures, but the road had become more rough and uneven than its age would warrant. In the northern part of the state there were a few materials that normally served as good roads, but after an exceptionally hard freeze, large sections of the asphalt top had "popped off" of the road.

A base which had many failures was classified as "Poor," regardless of its age. Failures which were apparently caused by insufficient depth of base, fill settlement, or by exceptional conditions such as floods or ground water seepage were not considered in this group. There was a good many cases, however, where seepage caused some exceptionally bad failures but many base failures could be found at other spots on the road. Where a sample was classified as "Poor," the sample was taken directly from one of these base failure spots. No attempt was made to obtain a control sample classified as "Good" from any part of a stretch of road that contained base failures. Occasionally, these smooth spots will prove to be better material than is found in the failure, but usually, they will contain about the same type of material, and may or may not fail later.

Each of these samples was dug from out the roadbase, with a sample of the subgrade underneath also being taken. Extremely large samples were taken of the base materials in order to make a large number of tests in each case. In the beginning each sample was tested for cementing value, slaking time, per cent soil binder, and each of the soil constants, mechanical analysis of the soil binder, ratio of voids to binder, pH value, and several experimental types of stability tests. When enough results were obtained on any given test to show that it would not serve as a satisfactory means of judging quality, the test was dropped from the list

[2] "Reports on Subgrade Soil Studies," Public Roads, Vol. 12, Nos. 4, 5, 7, and 8.



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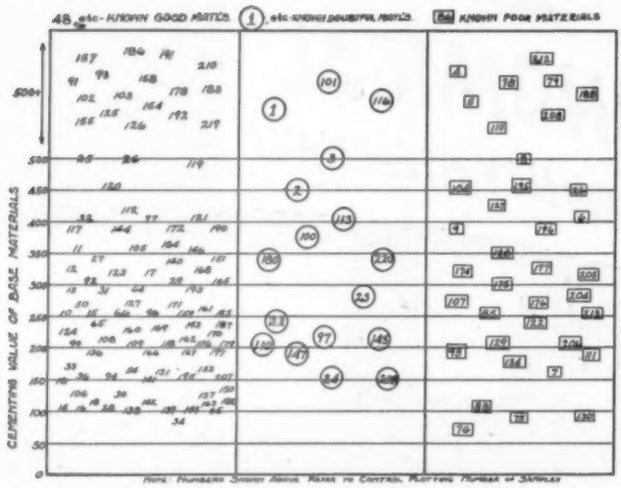

Fig. 1.—Texas Caliche Control Samples, Showing the Correlation of the Cementing Value vs. Known Behavior

in order to concentrate on those tests which showed greater possibilities.

It was felt at first that the samples would have to be divided into groups, depending upon some factor such as amount of rainfall in the locality, type of subgrade, or type of construction. Consequently, the various test results were plotted in many different types of relationship. It soon became apparent that the relationship of the percentage of soil binder plotted against the plasticity index or the linear shrinkage of the soil binder would separate the "Good" from the "Poor" materials, and that the borderline between the two groups fell at about the same place regardless of the other conditions mentioned above. It is true that where the climatic conditions are more favorable, a base material containing a highly plastic soil binder will probably take longer to fail, and the failures will not be as severe as they would be if the road were in a more unfavorable location; but failures are almost sure to occur eventually regardless of type of subgrade or depth of base. For fear of being misunderstood in this statement, we wish to emphasize the fact that we are trying to eliminate those base materials that will eventually accumulate enough water to cause them to fail within themselves. In these materials a base failure normally starts with the material "flowing away" from some point at the top of the base; and the subgrade and subbase, if any, may or may not be deformed at the point of failure. Traffic then drops into this depression and aggravates the condition.

If a satisfactory type of base material is used, the factors of rainfall, type of construction methods, etc., will have a great deal of influence on the depth of base that is needed and the riding qualities of the road in future years. In the case of a "Doubtful" or "Borderline" base material, these same factors will probably determine whether or not the materials will behave satisfactorily.

Figures 1 through 6 represent charts which show the correlation of the field behavior of the control samples with several of the tests which have been described. These samples represent caliches, crushed rocks, shales, and similar materials which have an angular type of aggregate. On all of these charts the control plotting number of the sample has been placed opposite its test value. The numbers representing known good samples are shown without enclosures, those of known doubtful samples are enclosed in circles, and those of known poor samples are enclosed in rectangles.

Charts Showing Correlation of Tests with Field Behavior

Figure 1 shows the correlation of the cementing value test with the field behavior of these base materials. It can be noted that the "Good," "Doubtful," and "Poor" materials all have about the same range of values, and a line drawn horizontally at any particular cementing value would have about the same percentage of samples above and below the line in each of the three columns.

Figure 2 shows the correlation of the slaking time test with the field behavior of these base materials. These results look very similar to the previous chart in that the three different types of material have about the same range of values, and a line drawn horizontally at any particular slaking time would not separate the "Good" from the "Poor" materials.

It has been previously stated in this article that base failures are caused by the active clay particles in a base material, but that the quality of a base material cannot be judged by the quantity of clay sizes that are present. Figures 3 illustrates this fact. A large number of the samples of "Good" materials (Nos. 70, 71, etc.) contain a much higher percentage of clay sizes than are present in some of the materials that have failed (Nos. 78, 107, etc.). The clay in these "Good" materials may be of a relatively inactive type or else mixed with more sand and silt particles.

In Figure 4 the per cent of soil binder (all particles smaller than 40-mesh in size) in each sample has been plotted against the liquid limit value of the binder, with the sample number written in at the point of intersection. It can be seen from this chart that the liquid limit alone cannot be used to separate the "Good" materials from the "Poor." In general, a caliche type of binder will have a higher liquid limit value than other types of soils, due principally to the shape and porosity of the sand and silt particles. Given two soils of equal plasticity index values in the same type, however, the one with the lowest liquid limit value will usually be the better type of binder. This is borne out by the fact that the few base materials on this chart which have proven satisfactory with a very high percentage of binder have liquid limit values generally below 35. In these samples the aggregate is "floating," and the soil binder alone must carry the load; therefore, the binder must be of excellent quality.

There are a few exceptional materials that would fail as a base because the soil binder would absorb enough water to become spongy and soupy, rather than plastic.

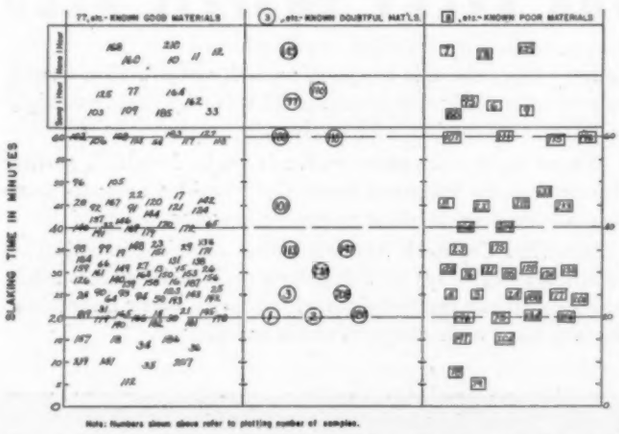

Fig. 2.—Texas Caliche Control Samples, Showing the Correlation of Slaking Time vs. Known Field Behavior

(*Continued on page 53*)

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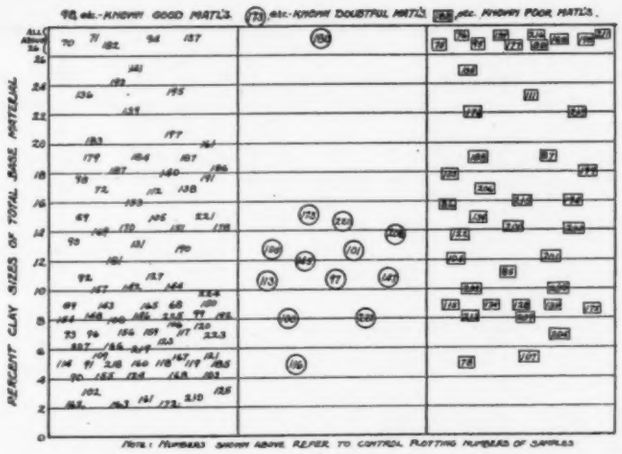


Fig. 3.—Texas Caliche Control Samples, Showing the Correlation of Per Cent Clay Sizes vs. Known Field Behavior

These materials would not necessarily have high plasticity index and linear shrinkage values, but could be detected by their high liquid limit values. The specification limit of caliches has been set as a maximum liquid limit of 45 to include practically all of the good materials on this chart (Fig. 4). For road gravels this limit is more nearly 35.

On Figure 5 each sample is plotted where its percentage of soil binder intersects the plasticity index of the binder. The plasticity index is the numerical difference between the plastic limit and the liquid limit and represents the range of plasticity of the soil binder. This plasticity index value is a measure of the activity of the soil binder mixture, and soils with a high activity will tend to accumulate enough water to reach a plastic state, in which condition they act as a lubricant between the larger aggregate. It can be seen that practically all of these base materials which have less than 50 per cent soil binder, and a plasticity index of 15 or less, have made satisfactory base materials. Practically all materials which fall in the area to the extreme right have failed under service. A narrow band just to the right of the specification limits and all of the area above the specification limits may be called a borderline group. The behavior of materials which fall in this area will depend upon other factors such as: climatic conditions, type of subgrade, drainage, construction methods, etc. Number 105 appears to be an exception in the "Bad Area" and Number 133 an exception in the "Good Area."

Materials which have a high percentage of soil binder with a low plasticity index will make a satisfactory base only if all other conditions are favorable, including the gradation curve of the soil binder itself. Many of the "Doubtful" samples in this group are from roads in the northern part of Texas which have not shown base failures, but after a period of a hard freeze, large sections of the top have "popped off." These materials have not accumulated enough water to cause failures, but due to the high percentage of binder, they apparently accumulated enough water to allow ice lenses to form and create expansion in the top of the base.

The specification limits for the soil binder in a caliche or crushed rock have been set at a maximum of 50 per cent in quantity and a maximum plasticity index of 15 in order to eliminate those soil binders which will be-

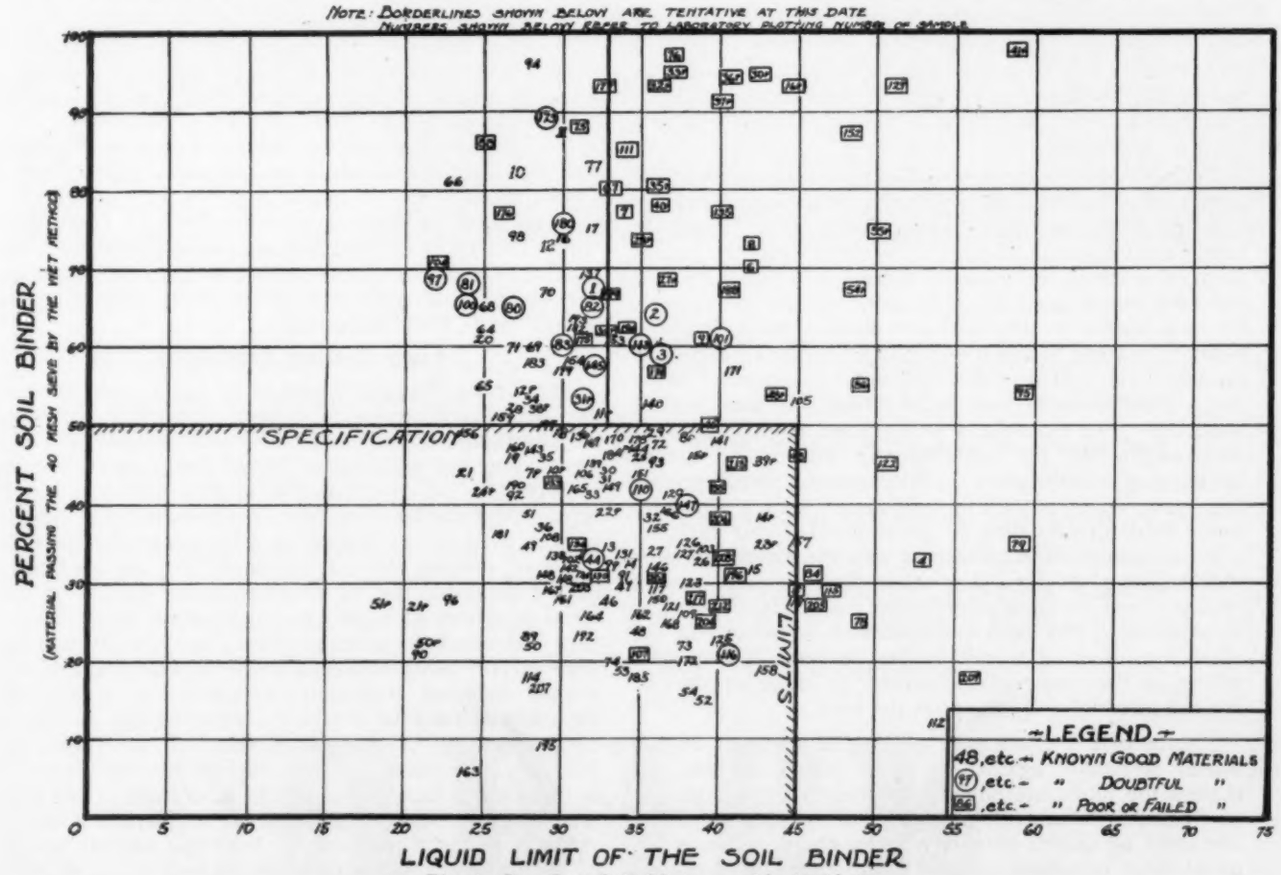

NOTE: BORDERLINES SHOWN BELOW ARE TENTATIVE AT THIS DATE
NUMBERS SHOWN BELOW REFER TO LABORATORY PLOTTING NUMBER OF SAMPLE
PERCENT SOIL BINDER
(MATERIAL PASSING THE 40 MESH SIEVE BY THE WET METHOD)
SPECIFICATION LIMITS
LEGEND
48, etc. = KNOWN GOOD MATERIALS
(97), etc. = " DOUBTFUL "
66, etc. = " POOR OR FAILED "
LIQUID LIMIT OF THE SOIL BINDER

Fig. 4—Per Cent Soil Binder vs. Liquid Limit
Texas Caliche Control Samples. Base Materials Sampled from Old Roads of Known Field Behavior. Showing the Correlation of Per Cent Soil Binder vs. Liquid Limit. 215 Samples Tested to Date: April 27, 1937.

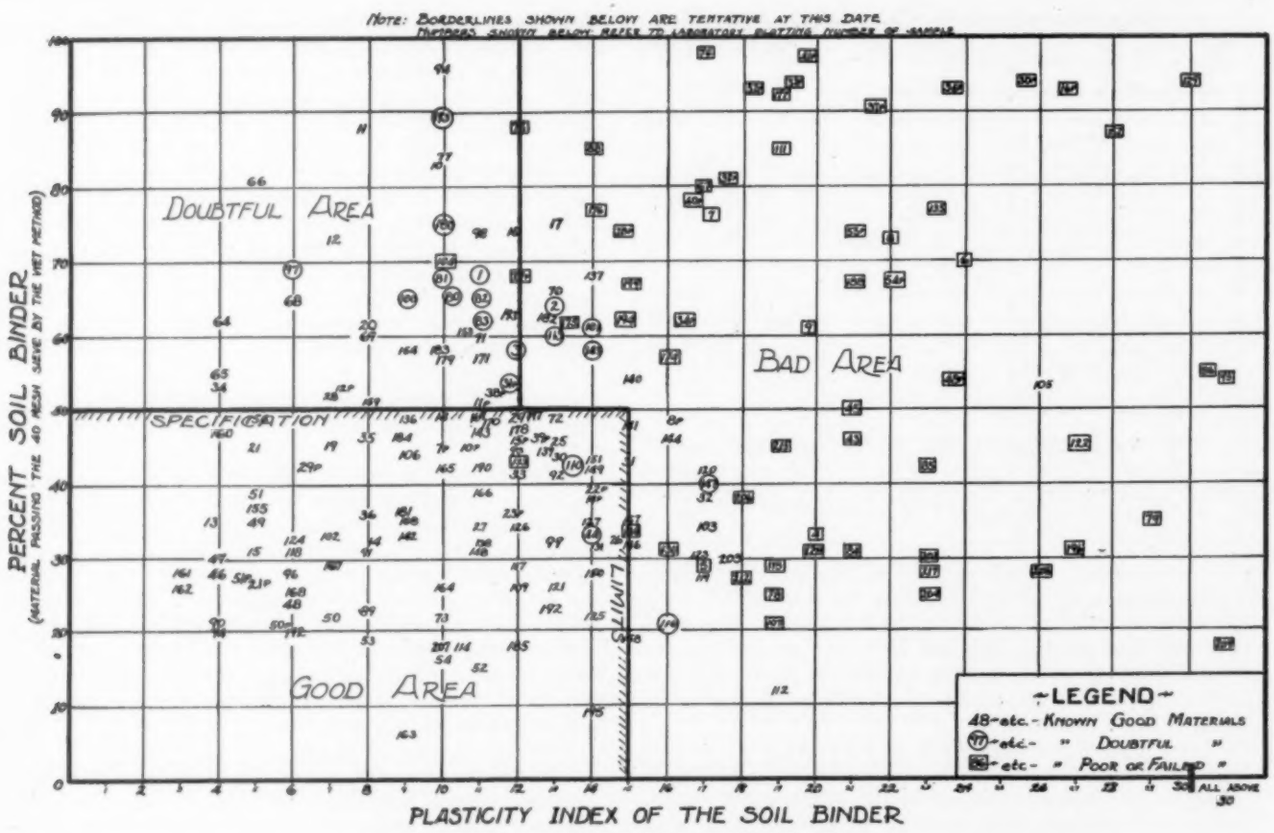

NOTE: BORDERLINES SHOWN BELOW ARE TENTATIVE AT THIS DATE
DOUBTFUL AREA
BAD AREA
SPECIFICATION LIMITS
GOOD AREA
LEGEND
48-etc.- KNOWN GOOD MATERIALS
77-etc.- " DOUBTFUL "
86-etc.- " POOR OR FAILED "
PERCENT SOIL BINDER
(MATERIAL PASSING THE 40 MESH SIEVE BY THE WET METHOD)
PLASTICITY INDEX OF THE SOIL BINDER
ALL ABOVE 30

Fig. 5—Per Cent Soil Binder vs. Plasticity Index
Texas Caliche Samples. Base Materials Sampled from Old Roads of Known Field Behavior. Showing the Correlation of Per Cent Soil Binder vs. Plasticity Index. 215 Samples Tested to Date: April 27, 1937.

come plastic and fail if placed in a base. There is a possibility, however, that some of the materials failing within these limits will not have enough cohesion to hold together when dry.

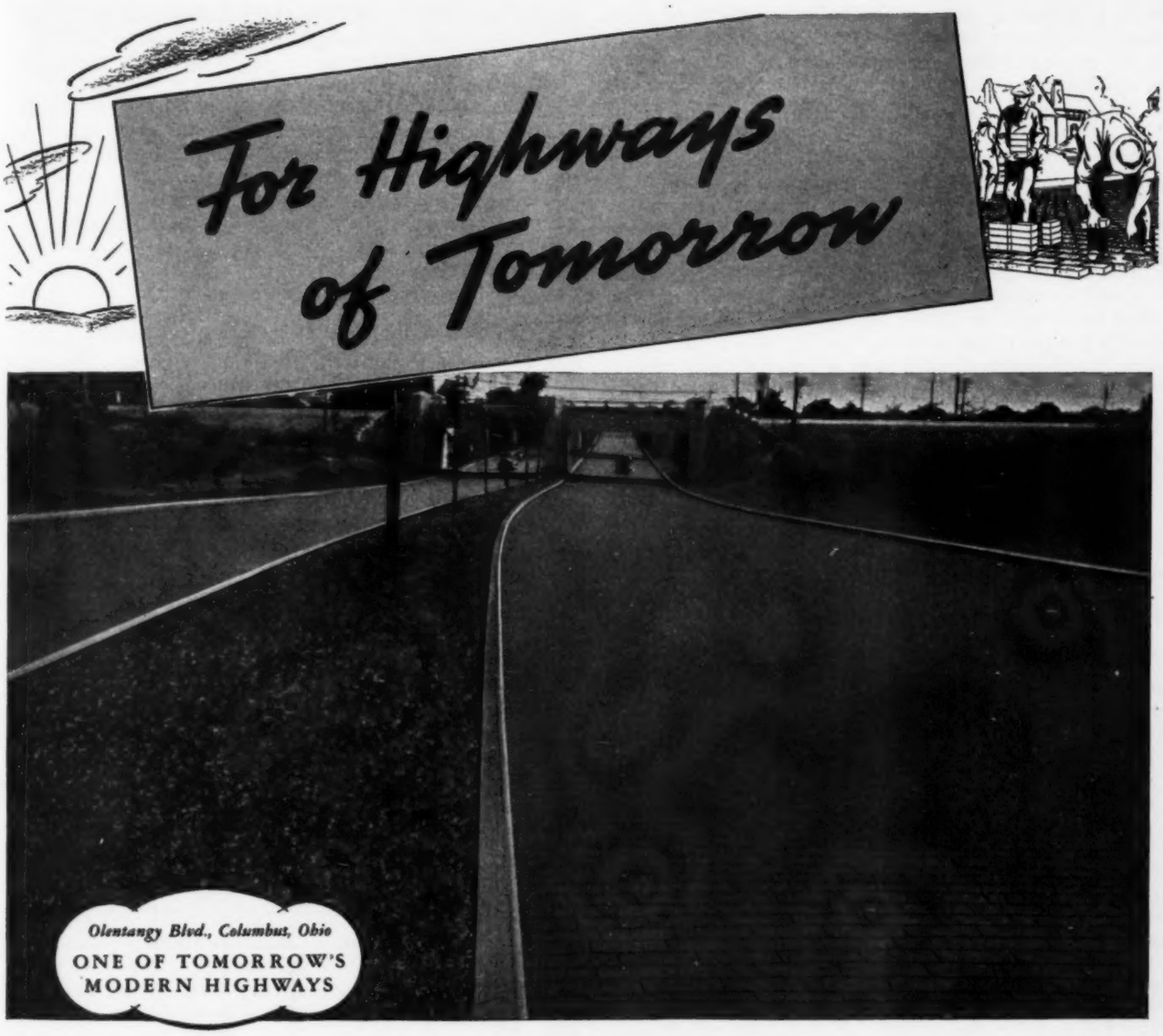
Probably the best range of plasticity index for a soil binder in a base material is somewhere between 5 and 10, depending upon the shape and grading of the aggregate larger than 40-mesh in size. For plasticity index values above this range the material increases in plasticity and becomes more unstable when wet. Below this range, the soil binder begins to lose cohesion until finally a point is reached where the mixture contains practically no active clay particles and will not hold together when dry. This lower critical point is not the same for all materials. For example, a well-graded, angular crushed rock might "set up" satisfactorily with a soil binder having a plasticity index of 1, whereas a poorly-graded aggregate might require a soil binder with a plasticity index value greater than 4. In addition to this variable, it is extremely difficult for even an experienced operator to obtain a plasticity index value more accurate than 2 or 3 per cent on these cohesionless materials. For these reasons there has been no minimum value set on the plasticity index of a soil binder; instead, it has been left up to the construction engineer to judge whether or not the material will set up on the road.

Figure 6 is a charter on which the per cent of soil binder is plotted against its linear Shrinkage and, although the limits are slightly different, the arrangement of "Good," "Doubtful," and "Poor" samples is about the same as on the plasticity index chart. This is because these two tests measure about the same property, i.e., the resultant activity of the soil binder mixture. The field method of making the linear shrinkage test by using a bar specimen is easier and does not require as much training as the other tests. It is unfortunate that it is not accurate enough to be used alone for field control. The linear shrinkage values plotted in Figure 6 were obtained by the volumetric pat method at the Austin laboratory.

In addition to these samples, many have been taken from other types of base materials which show the same general type of correlation with the three soil constants but which show slightly different limits separating the "Good" and "Bad" materials.

Field Testing Procedure

The Texas Highway Department has revised its flexible base specifications to include maximum limits for the percentage of soil binder and each of three soil constants, together with rather liberal limits as to grading requirements of the material larger than 40-mesh in size. One resident engineer from each field division spent a week in the Austin laboratory learning the technique of making the soil constants and the application of the tests for use in controlling the quality of material produced at a pit on a field job. These men in turn instructed the other engineers in their division and also several plant inspectors. It is realized that one sample does not accurately represent a pit; therefore, the material must be constantly tested on the job during excavation and production to insure a uniformly satisfactory base course. To accomplish this, the contractor is required to build a small field laboratory at the plant site, and the engineer is required to furnish a trained plant inspector whose duty it is to test several samples of the finished product each day as well as the different types of materials encountered in the pit. This plant inspector is furnished a field soil kit of laboratory equip-



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THE BEST PAVEMENT FOR MODERN TRAFFIC

ment, a manual of test procedure for the field tests, and several soil binder samples of known test constants which can be used occasionally to check his technique in making the tests.

The following paragraphs describe the procedure followed in any one of the field laboratories for testing a sample of base material which will be assumed to be a product of the crusher. If the sample is taken from the pit, it should be broken up in such a manner as to approximate the action of the processing plant and a 3 to 5 pound portion accurately obtained by quartering.

The first problem is to separate the soil binder, which consists of all particles smaller than 40-mesh in size, from the remainder of the aggregates. This cannot be done while the material is dry, for not only is each large piece of aggregate coated with a layer of soil binder, but many of the lumps themselves consist principally of soil binder and will slake in the presence of water. The sample is first dried at a temperature not to exceed 212° F., weighed, then allowed to soak in water long enough to slake all of the soil binder. It is quite essential that the sample be dried before any slaking is attempted, because a few hours slaking will usually be satisfactory if this is done, whereas a ball of wet clay may resist the slaking action of water for days.

After the sample has slaked sufficiently, an 8-inch, 40-mesh sieve with two-inch sides is placed in a large clean milk pan and the free water poured off the sample through this screen. Sufficient clean water is added to bring the water level about ½ inch above the mesh of the sieve. About one pound of the slaked material is put on the sieve and stirred around by hand while the sieve is agitated up and down until all of the soil binder appears to have passed through the meshes. If the slaked material contains lumps that have not disintegrated down to binder sizes, but which can be easily crumbled between thumb and forefinger so as to pass the 40-mesh sieve, such lumps should be broken and washed through with the binder. The assumption is that any such soft material will be broken down during the process of construction in the road.

The sieve is then held above the water and the remaining material therein washed by pouring over it a small amount of clean water. This retained material is then placed into a separate pan and another batch of the slaked material placed on the sieve and washed as before. After the total sample has been thus washed, any water present in the retained material is poured out and the material oven-dried and weighed. The per cent of material larger than 40- mesh is then calculated as:

$$100 \times \frac{\text{dry weight of materials retained on 40- mesh}}{\text{original dry weight of total sample}}$$

and % Soil Binder = 100 — % retained on 40-mesh.

This retained aggregate may then be dry-screend to check the grading requirements set up in the specifications.

After the washing process the soil binder will contain a large amount of surplus water, but if the pan is left undisturbed for several hours, the soil will settle to the bottom leaving the surplus water in a practically clear layer on top. If the binder does not settle within a reasonable length of time, the addition of not more than one tablespoon of water saturated with common table salt can be mixed in to flocculate the particles.

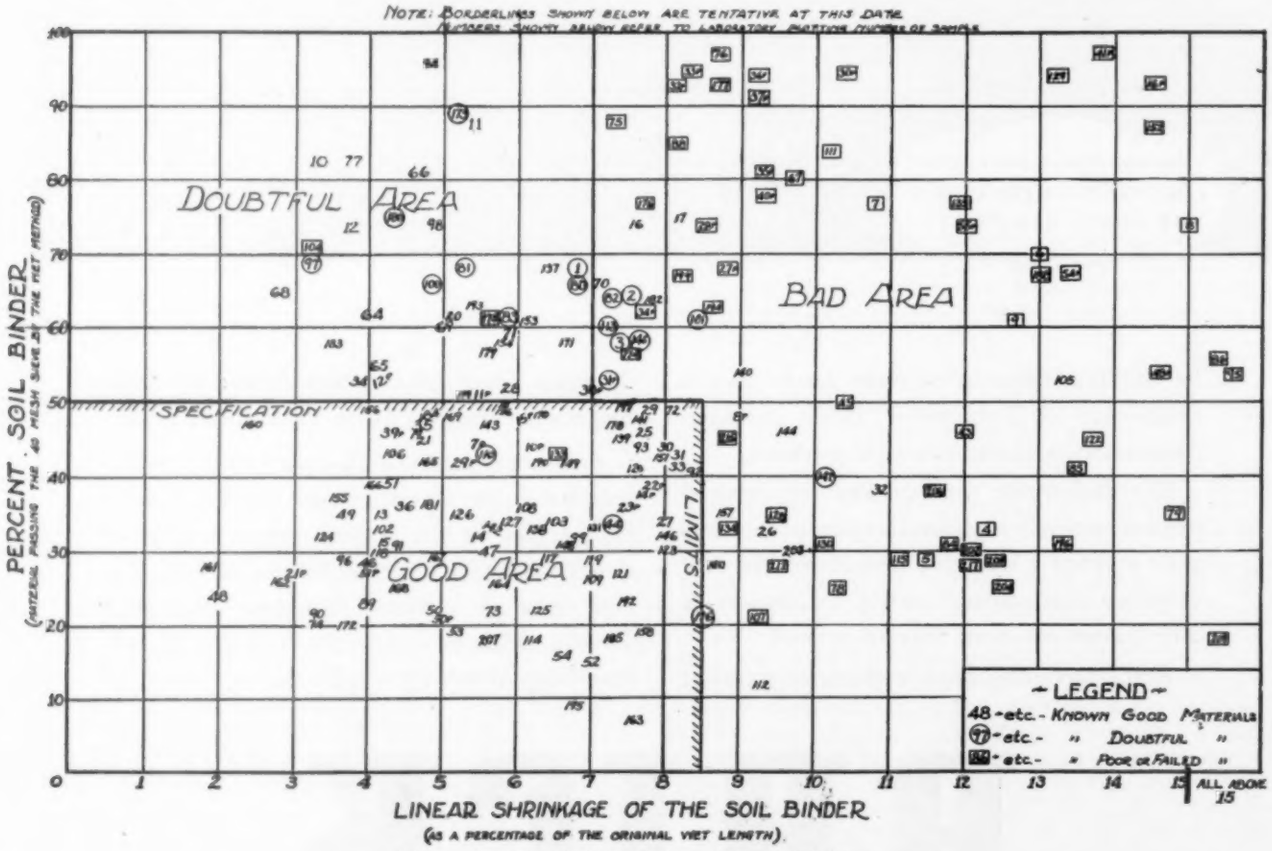
NOTE: BORDERLINES SHOWN BELOW ARE TENTATIVE AT THIS DATE.
DOUBTFUL AREA
BAD AREA
GOOD AREA
SPECIFICATION LIMITS
PERCENT SOIL BINDER
(MATERIAL PASSING THE 40 MESH SIEVE BY THE WET METHOD)
LINEAR SHRINKAGE OF THE SOIL BINDER
(AS A PERCENTAGE OF THE ORIGINAL WET LENGTH)
ALL ABOVE 15
LEGEND
48 - etc. - KNOWN GOOD MATERIALS
77 - etc. - " DOUBTFUL "
166 - etc. - " POOR OR FAILED "

Fig. 6—Per Cent Soil Binder vs. Linear Shrinkage

Texas Caliche Samples. Base Materials Sampled from Old Roads of Known Field Behavior. Showing the Correlation of Per Cent Soil Binder vs. Linear Shrinkage. 215 Samples Tested to Date: April 27, 1937.

(*Continued on page 61*)

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Most of the free water can be siphoned off with a piece of rubber tubing. From this point on, the binder is dried (not to exceed 212° F.), weighed in order to check the calculation of per cent soil binder, and prepared to pass the 40-mesh sieve.

A "prepared" soil binder is merely a mixture in which all of the particles are smaller than 40-mesh in size and all of the lumps have been broken down so as to pass the 40-mesh sieve without fracture of any of the individual grains. The purpose of this preparation is to separate the materials into small enough "clods" so that all of the material will be thoroughly mixed and uniformly wetted in the making of the various soil tests. A portion of the dried soil binder is put into a stone mortar and broken down with a stone pestle until all lumps are smaller than about 1/16 inch in diameter. The material is then sieved on a 40-mesh sieve, and the retained portion returned to the mortar. A rubber-covered pestle is now used to take the remaining material down to just past the 40-mesh sieve without fracturing any of the individual grains. When this is done to all of the sample, it is thoroughly mixed. The soil binder is then "prepared" for testing.

The *Liquid Limit* represents the consistency at which a soil or soil binder changes from a plastic to a liquid state. The proper consistency is reached when a standard groove in the soil just closes with either 25 blows using a liquid limit device[3] or 10 standard blows by the hand method. Each method has its advantages, with the liquid limit device probably giving the more dependable results from operators having a small amount of training. The Texas Highway Department has made some comparative tests using both methods but at the present time is using the hand method entirely for the following reasons (1) only one moisture content sample is put up when the end-point is reached as against four or more when the device is used, (2) a big saving in total time consumed for making the test, (3) eliminates the expense of a device for each field kit, (4) with a trained and experienced operator the hand method appears to give as accurate and consistent results as can be obtained by the liquid limit device.

The following procedure is followed in making the liquid limit test by the hand method. The required equipment consists of two evaporating dishes of cast aluminum, one stainless steel spatula with 4-inch blade, one liquid limit grooving tool, one 50 cc. graduated burette with stand, one Welsh triple-beam balance (1110 gms. capacity), and one aluminum weighing box with lid. An approximate check on the per cent of water used is obtained by measuring the water from a burette and using prepared soil binder out of a dish previously weighed.

In making the liquid limit test about 15 cc. of water, more for a clay-type soil and less for a sandy-type soil, is placed in an evaporating dish and dry soil added to it until practically all of the free water has been absorbed. The mixture is then thoroughly mixed for several minutes using the broad side of the spatula. Additional increments of dry soil are then added to the mixture, and the material is thoroughly mixed after each addition of soil.

When the material attains the consistency of a fairly thick paste, it should be tested to see if the end-point has been reached. The material is pressed against one side of the dish, smoothed off in a layer about 3/8-inch in thickness, and a clean groove cut in the soil with a metal grooving tool. The dish is then held in one hand, with the groove on the outside, and struck lightly

[3] "A Short Course in Soil Stabilization," Page 35, ROADS AND STREETS, March, 1938.

against the heel of the other hand ten times. An operator can obtain the proper technique for these blows by a period of training under a skilled laboratory operator. If the groove does not close with ten blows, more water is added and thoroughly mixed; if the groove closes with less than ten blows, more dry soil is mixed in and the test repeated.

When the end-point of the soil cake in the dish is finally reached, i.e., a half-inch length of the groove just closes on the tenth blow, a large portion should be placed in a moisture can, weighed, oven-dried to constant weight, and weighed agin. The liquid limit is the per cent of water, by weight of oven-dried soil, required to bring the soil to the consistency described above.

Then,

$$\text{Liquid Limit} = 100 \times \frac{\text{Wt. of wet soil and can—Wt. of dry soil and can}}{\text{Wt. of dry soil and can—tare weight of can}}$$

The *Plastic Limit* is the moisture content, expressed as a percentage of the weight of oven-dried soil, at which a soil changes from a semi-solid to a plastic state. The end-point of the test is a consistency at which the soil can be rolled into threads ⅛-inch in diameter, and no smaller, without breaking into pieces. It is not possible to obtain an accurate "burette check" on the moisture content used in this test.

The easiest procedure for starting this test is to use a portion of the wet soil that is left over from the liquid limit test, but if this is not available, a portion of the dry soil and water is mixed to a consistency somewhat wetter than the plastic limit of the soil. A ball of the wet material is taken from the dish and dry soil added and mixed in thoroughly with the fingers. The ball is then compacted to a dense mass and placed under the palm of the hand on top of a smooth glass or heavy brown paper. The operator should attempt to roll out a thread about two inches long and less than ⅛ inch in diameter. If such a thread can be formed, the material is too wet and more dry soil should be thoroughly mixed in and the test repeated.

When the thread can be rolled down to a diameter of about one-eighth inch and begins to break up at that point, the end-point of the test has been reached and the soil is at the plastic limit. All of the broken threads should be gathered up and placed in a moisture can, weighed, oven-dried to constant weight, and weighed again. The percentage of moisture in the soil is called the plastic limit of the soil and is calculated as:

$$100 \times \frac{\text{weight of wet soil and can—weight of dry soil and can}}{\text{weight of dry soil and can—tare weight of can}}$$

The *Plasticity Index* is the range of plasticity in a soil or the range of moisture constant through which the soil remains in a plastic state. By definition it is the numerical difference between the liquid limit and the plastic limit, or

$$\text{Plasticity index} = \text{Liquid limit—Plastic limit}$$

The field test for *Linear Shrinkage* of a soil binder is the per cent of shrinkage, on the basis of the original wet length, acquired by a soil bar in drying from its liquid limit down to its shrinkage limit (the moisture content at which all shrinkage ceases). The preliminary shrinkage of soils containing water in excess of the liquid limit is in a downward direction. Therefore, the *Linear* Shinkage of the soil bar as measured in this test will not be materially changed if the specimen is molded with an amount of water in excess of the liquid limit. In fact more accurate results will be obtained from specimens mixed as described below rather than those made at exactly the liquid limit consistency.

Either the dry "prepared" material or the wet soil binder may be used in preparing specimens for the test, but the dry material is preferable. If the dry material is used, about one-third of a cup of water, more for a clay-type and less for a sandy-type material, should be placed in an evaporating dish and the dry soil added to and thoroughly mixed in with the water until a consistency slightly more fluid than the liquid limit is reached. The importance of a thorough mixing in this and all other tests cannot be over-emphasized.

The sample should be formed into a smooth layer about one-half inch thick on the side or bottom of the dish and a groove cut with a grooving tool or blunt pencil. If the material flows freely and closes the groove of its own accord behind the grooving tool, more dry soil should be added and thoroughly mixed in; if several blows are required to make the groove close, more water should be added and thoroughly mixed in and the test repeated.

The material is at the proper consistency for molding when a slight tilting of the dish or one light jar will close the groove made by the grooving tool. Metal molds have been found to be the best type for this test, and those used by the Texas State Highway Department are 5-gang, cast aluminum molds with removable end plates for ease of cleaning. The mold should be ¾ inch wide, ¼ inch deep and 5 inches long. The inside walls of the mold should be thinly greased with white petroleum jelly before the specimen is formed. The wet soil mixture should be placed in the mold in small increments and worked with a spatula to remove all air bubbles. As soon as the mold has been properly filled, the excess should be struck off and the specimen smoothed down level with the top of the mold.

If in making this test a metal mold is used, it may be placed in an oven (temperature not greater than 200° F.) to dry immediately after the specimen is formed, provided that it is not a very plastic type of soil. Specimens formed of plastic soils, i.e., those with a plasticity index greater than 15, should be dried at less than 140° F.

When the specimen has dried to constant length, the loss in length is measured to the nearest 1/40 of an inch.

$$\text{The \% Linear shrinkage} = 100 \times \frac{\text{loss in length}}{\text{original length}}$$

When every precaution is taken to insure accuracy in making this field test, the results will usually be within 2 per cent plus or minus linear shrinkage of the results obtained by the volumetric pat method used in the Austin laboratory.

Significance of Test Findings

The present Texas Highway Department specifications for caliche-type flexible base material require the following:

Passing the 2-inch round screen..... 100%
Passing 40-mesh (soil binder)..... 15%-50%
Liquid Limit of the soil binder....not to exceed 45
Plasticity Index of the soil binder..not to exceed 15
Linear Shrinkage of the soil binder.not to exceed 8.5

These specifications will keep out a few materials which would possibly make a satisfactory road base but should eliminate all highly plastic materials which would prove unsatisfactory under service.

Why Copper Steel is the *Right* Material for Culverts

COPPER STEEL CULVERTS STAND UP under the constant pounding of traffic. The corrugations form strong repeated arches capable of carrying heavy loads.

COPPER STEEL RESISTS CORROSION. Countless installations and numerous tests conducted by independent testing laboratories show that U·S·S Copper Steel has the highest atmospheric corrosion resistance of any commercial culvert metals.

NO CRACKING OR BREAKING from shifts in sub-soil. Corrugated culverts are built like accordions, with enough flexibility to adapt themselves to changing soil pressures without failure.

TRAFFIC INTERRUPTIONS CAN BE PREVENTED. Copper Steel culverts are installed quickly and easily, often without stopping traffic. The result is substantial savings in time and labor costs.

LOW INSTALLATION COST. Copper Steel culverts eliminate much expensive foundation and form work, can be handled with fewer men and do not require highly skilled labor.

PERFORMANCE is the main objective in culvert installation—and the story of U·S·S Copper Steel is one of better performance at lower cost. The most convincing evidence of this is the fact that no culvert made of U·S·S Copper Steel has ever been known to fail structurally in service.

Copper Steel culverts are designed to resist such forces as sudden freezes, rapid thaws, sub-soil changes, heavy weight and vibration. They do not crack or fail under stresses that might destroy rigid materials.

Another strong advantage of U·S·S Copper Steel is its endurance. In 1911 U. S. Steel engineers discovered that a little copper added to steel more than doubles its resistance to rust and atmospheric corrosion under alternate wet and dry conditions. When galvanized, U·S·S Copper Steel has proved over a period of years to be a most enduring, low-cost culvert material.

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COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*

United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

With a definite means of test at hand, there will probably be base materials used which have previously been disregarded for some reason such as being off-color, or because they made a poor open-surface road. On the other hand, an unsatisfactory type of base material can be tested to determine just what is needed to convert it to a satisfactory type. Quite often the necessary material for admixing can be found at the pit site, or nearby, and added during the normal processing at little or no additional cost.

In many cases, however, suitable material for admixing will not be economically available, or else the mixture will contain too high a percentage of soil binder to start with. If the material is to be used in these cases, some other type of stabilizing agent will have to be considered, such as, cement, asphalt emulsion, lime, etc. No one type is suitable for all cases, and the one to be used is an engineering problem in each case.

Inspecting a base material by visual inspection is like examining food for germs; the particles that cause all the trouble are too small to be examined by the human eye. A good type of base material should have enough of a fairly well graded aggregate to furnish stability and carry the load, with a soil binder that furnishes just enough cohesion to hold the mass together. This soil binder must not be of a highly plastic type, because if there is enough of this binder to set up the mixture, there is probably enough to cause failure. The plasticity index and linear shrinkage can usually be depended upon to determine the degree of plasticity. What is still more important, these tests can be used by the field engineer to test a pit before construction starts, and also during operations, to insure the obtaining of satisfactory base materials.

▼

Safety Installation on Tennessee Bridge

The Walnut Street bridge in Chattanooga, Tennessee, is an old structure on which the sidewalks were separated from the roadway by the common device of a timber stringer, or curb. The inadequate protection afforded to both pedestrians and motorists by a barrier

Metal Guard Rail on Old Timber Curb, Walnut Street Bridge, Chattanooga, Tenn.

which can be run over so easily led the city to install the metal guard rail shown in the picture on top of the old timber. The rail is a product of the Tuthill Spring Company, and so far as we know, is the first installation of its type under conditions like those at this Chattanooga bridge.

MINNESOTA KEEPS ITS NEATNESS

Working on the premise that "roadsides are the front yards of Minnesota," the Minnesota highway department in 1938 has expended every effort not involving the spending of additional maintenance funds to keep its trunk highways attractive.

District maintenance engineers have been instructed by their chief, L. L. Allen, that backslopes must be maintained with at least a 2.1 slope and that when material has been removed from these backslopes they must be immediately topsoiled and seeded or sodded to ground cover.

Borrow pits are now selected so as to be completely screened from the highway. The order has also gone out to locate stockpiles of sand, gravel and treated sand and gravel at points where they cannot be seen from the roadway.

In addition, the roadside development division of the Highway department has continued its work of beautification, being assisted by the National Youth Administration.

N. W. Elsberg, Minnesota Highway Commissioner, points out that by planning ahead and by employing good taste engineers can construct and maintain highways with roadsides that are not eye-sores, with no additional cost to the taxpayers. These highways in turn will pay good dividends in more permanent grades, stoppage of erosion, lessening of snow removal costs and advertising the state to tourists.

▼

RELOCATION OF U. S. 20 ON OLD RAIL LINE BETWEEN ELGIN AND BELVIDERE, ILLINOIS, WOULD REMEDY BAD CONDITIONS

Offering a solution to one of the worst highway conditions in Illinois, a group of public spirited citizens in Belvidere, Marengo and Elgin are proposing that the State Highway division relocate U.S. 20 between Elgin and Marengo from the present hazardous site to the straight rail line of old Elgin, Belvidere Electric Railroad.

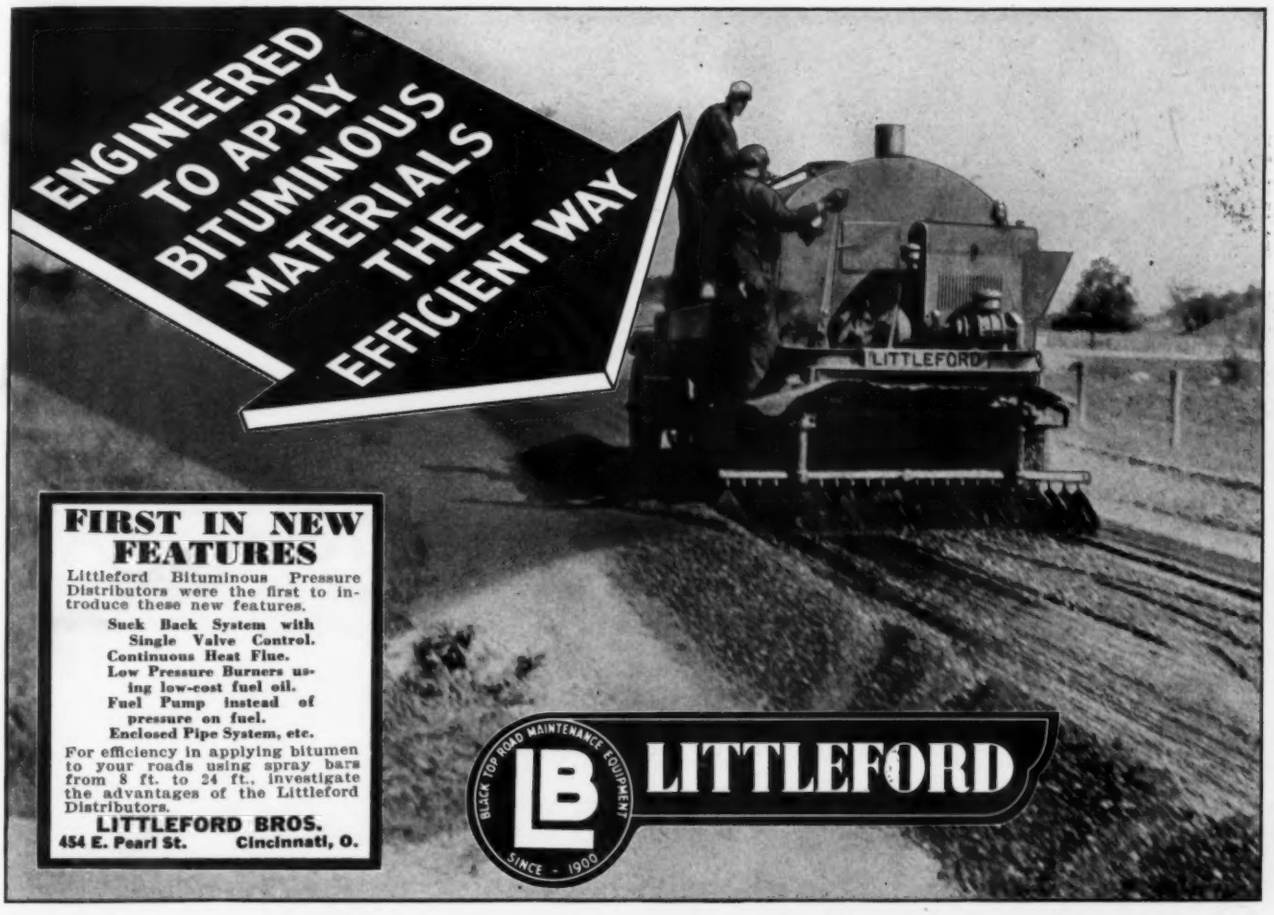
Such a relocation would eliminate over ninety curves which now exist on the twenty-five mile stretch of U.S. 20 between Elgin and Marengo and shorten the distance by 3 miles. Probably no section of highway on the entire state system has such an obsolete roadway. The terrain is rolling and the old pavement was practically laid on the natural contours without much grading or alignment. As a result motorists, if not confronted with the constant approach to blind curves, are harassed by very short sight distances on small hills which tend to keep passenger cars behind slow trucks or expose them to oncoming traffic when attempting to pass.

U.S. highway 20 is one of the most important transcontinental routes and carries a very heavy flow of traffic between Chicago and Rockford. This heavy traffic together with the obsolete condition of the road especially between Elgin and Marengo makes this route exceptionally dangerous.

Something has got to be done with the present route in behalf of highway safety, and the group of citizens favoring the modernization of U.S. 20 declare that the relocation of this road on the old rail line is the most logical answer to this pressing problem.—*News-Bulletin of the Illinois Road Builders' Assoc.*

▼

HIGHWAY RESEARCH BOARD TO MEET NOV. 30 TO DEC. 2.—The eighteenth annual meeting of the Highway Research Board will be held in the National Academy of Sciences at Washington, D. C., on November 30-December 2, 1938, according to a recent announcement.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BLACK TOP ROAD MAINTENANCE EQUIPMENT
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A NEW IDEA IN SCRAPERS

Taking a cue from the old style slip scraper, flat angle digging has been developed by Baker in the new Model 190 2½ cu. yd. Hydraulic Scraper for 20 to 30 H.P. Tractors.

Announcement of larger sizes of this type of scraper will be made later when production begins.

BAKER HYDRAULIC SCRAPERS

Model 190 2 1-2 Cubic Yard Capacity

Here's something new in scrapers. It loads at a flat digging angle, filling the rear of the pan first, getting its load quickly with less power and automatically provides rear clearance when ready to dump or spread. It is simple in operation and construction and really piles up the yardage at new low costs.

FLAT DIGGING ANGLE FILLS WITH LESS POWER SPREADS AS IT DUMPS

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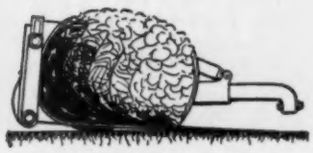

CAPACITY LOADS - FASTER - EASIER

Obsolete, Dangerous, Inadequate Canyon Crossing of Little Colorado River at Cameron, Arizona.

ANOTHER OBSOLETE BRIDGE THAT SHOULD BE REPLACED

Old Narrow Suspension Span Over Little Colorado River Has Served Its Time

By VICTOR J. BROWN
Publishing Director
ROADS AND STREETS

OBSOLETE is the best descriptive word to apply to the 660-ft. suspension span which carries U. S. 89 across the Little Colorado River canyon at Cameron, Arizona. *Dangerous* is also applicable because the floor system is not strong enough to carry the loads of today. After a power shovel or a heavy truck had crossed the bridge one day, unknown to the state engineers, it was discovered that a series of floor stringers had failed. Naturally, the bridge department of the Arizona State Highway Commission made an analysis of the strength of the existing structure to determine what load could be safely carried. Inadequate, while a part of the general conception of the word "obsolete," should also be applied. The bridge is only 16 ft. wide and, at present, traffic must stop on one end whenever a bus or large truck is crossing. The writer rattled his way across the timber floor after waiting for a large truck to get across. In order not to have to wait for another truck not far behind the one on the bridge, he "stepped on the gas" to get across rather than be caught on the bridge when the next truck drove on it.

An example of the inadequacy of the bridge is exemplified by the fact that after a herd of sheep had been driven onto it, the discovery was made that either (1) the cables had slipped forward on the tower roller caps or (2) the backstays had elongated. That, apparently was the heaviest load ever on the bridge. The herd filled the floor area from end to end. During the course of the life of the present suspension span, the suspender clamps have slipped on the steepest part of the main cables and have been jacked back into place. To keep them in place, a second clamp has been placed below the suspender clamp. The present structure was built in 1912 when horsedrawn traffic was the major type of transportation.

Historical

The first effective effort made to colonize and develop community life in the Rocky Mountain Region was made by Mormon pioneers. It is true that trappers, scouts, guides, and Men of the Cloth had traveled approximately the route of this road before, but it was the Mormons who used it most in reaching out to settle the fertile valleys of what is now Arizona. When those pioneers first entered what is now the southern part of Utah and northern Arizona, it was a wild, uninviting part of our country; the hunting grounds of the Ute, the Piute, and the Navajo. The present town of Mesa, about 15 miles east of Phoenix was settled by the Mormons.

When the road was first opened as such it was to be a star route for the carrying of mail and passengers between Flagstaff, Ariz., and Kanab, Utah. It was just a wagon track across the deserts of Utah and Arizona. Like the old cattle trails of the West, it followed the line of least resistance. Nary a single bridge or culvert was installed on its many deep, muddy "washes" or rocky canyons. To this date, this road is the *only* road crossing into Arizona from Utah, on the north.

From the Little Colorado settlements the road led down along the east bank of the river until it reached a point a few miles above the location of the present Cameron bridge. Here it turned into and down Moenkopi Wash, passing two small settlements, Moenkopi and Tuba City. The latter was named for the old Hopi chief "Tuba," which means "pine trees." It followed the wash for about 25 miles, then turned out and crept along the east side of the "Echo Cliffs" and down some long ridges that ultimately led to Lee's Ferry. The road down Moenkopi Wash was frightfully rough, its course strewn with wrecks of abandoned wagons.

This old route is steeped in historical background.

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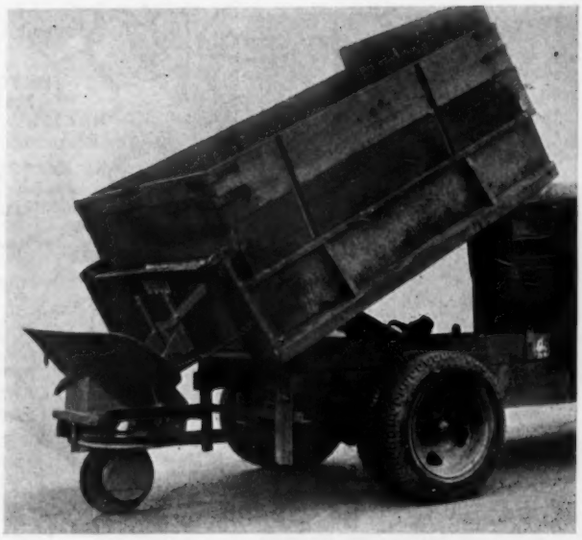
At 10 mph the Good Roads Model S spreads anti-skid mixtures to a width of 25 feet. Width of spread is regulated by hinged deflector plates. Adjustable cone in hopper controls flow of material to spinner disk. Spinner disk is gear-driven from pneumatic-tired traction wheel. Entire spreader ruggedly constructed of steel plate and angles, electrically welded throughout.



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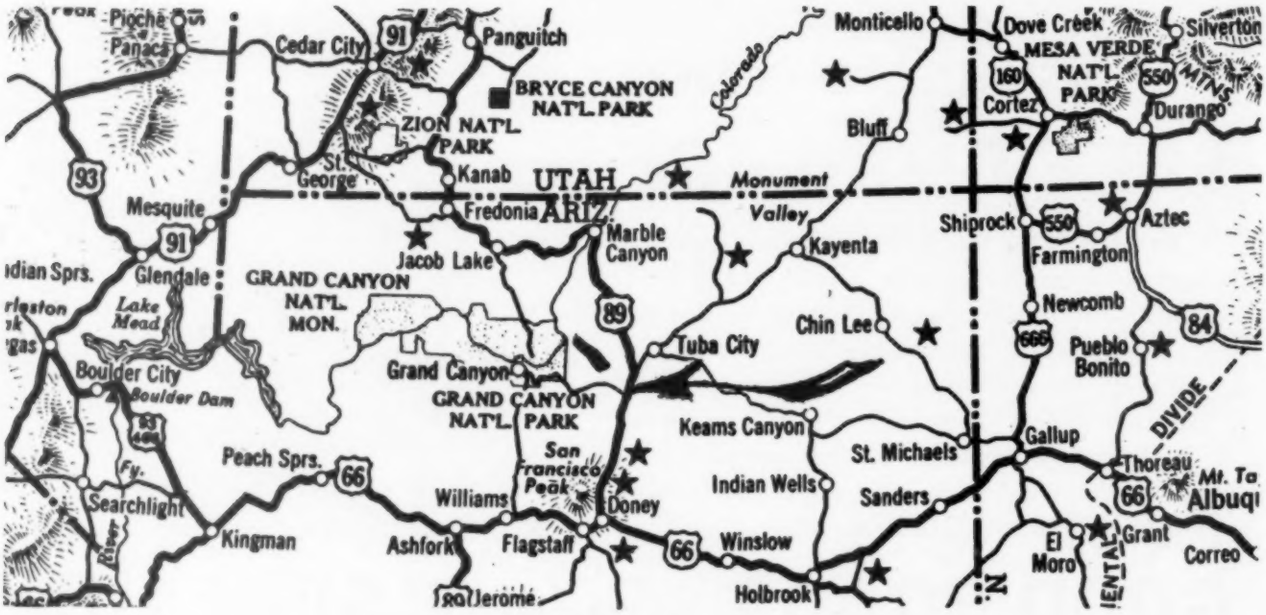
MICHIGAN POWER SHOVEL COMPANY
Benton Harbor, Michigan



Arrow Points to Location of Proposed New Bridge.

Enough was cited here to indicate the future interest that will be evidenced by increased traffic as the feeder roads become increasingly improved.

Traffic Data.—As stated before, this road is the only direct connection on the state highway system between Arizona and Utah. It also serves as a connecting link between the North Rim and the South Rim of Grand Canyon National Park. The terrain over which it passes is primarily a summer recreational area. Great Salt Lake, Bryce Canyon National Park and Zion National Park in Utah, with Kaibab National Forest and the Painted Desert on the north, and more of the Painted Desert, Wapatki National Monument, Sunset Crater National Monument, and San Francisco Park on the south, the Cameron bridge is an important connecting link to the improved highways.

A great deal of improvement has been made on this road within the last two years by the Arizona State Highway Commission with the assistance of Federal Aid funds. The 160 miles of roadway between Flagstaff and Jacobs Lake now has an asphaltic treated surface, which is undoubtedly an encouraging influence to the tourist who prefers to stay on paved roads.

It is probable that the 25 per cent increase in traffic on this road during the past year is accountable to a great degree to the fact that the road has been improved. The months which show the greatest amount of travel on this road are June, July and August. Between Cameron and Jacobs Lake there is approximately 300 vehicles per 24 hour-average during these three months. On this same road during the winter months, December, January and February, the traffic averages less than 100 vehicles per 24 hours.

The portion of the road between Cameron and Flagstaff during the summer months bears about 100 vehicles more than the section above Cameron, or about 400 vehicles per 24 hours. During the winter this is shrunk to slightly over 100 vehicles per 24 hours. The reason for the great variation between summer and winter traffic is due to unpleasant weather conditions in the winter and the swell of vacation tourists in the summer.

Of the traffic now observed on this road, about 41 per cent are vehicles with out-of-state licenses; the remaining 59 per cent bearing Arizona plates. Seventy-five per cent of all vehicles observed here are passenger cars and 25 per cent are commercial vehicles or trucks.

Fredonia, which is on this highway at the border between Arizona and Utah, is said to be the town which is farthest from a railroad of any town in the United States: hence, all freight operations serving points north from Flagstaff on U. S. 89 are conducted by trucks. About 70 miles of U. S. 89 runs through the Navajo Indian Reservation. Considerable trading with the Indians is conducted at Cameron.

Table I shows the 24-hour average by months during 1937 and 1938, which might be of interest:

TABLE I—TRAFFIC BETWEEN JCT. U. S. 89 AND ARIZ. 64—CAMERON

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average Daily Traffic
1937.....	97	125	186	238	272	413	406	488	347	255	223	107	263
1938.....	140	132	190	322	249	508	550	652	...	...	...	...	...
Average daily traffic 1938 estimate.....													323

Type of 1937 Traffic Between Jct. U. S. 89 and Ariz. 64—Cameron—			
Foreign	40.9	Passenger cars	74.7
Local	59.1	Trucks and busses	25.3
	100.0		100.0

Traffic Between Jacobs Lake and Lee's Ferry Bridge—

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
1937.....	6	12	31	87	171	262	235	296	165	173	161	85	...
1938.....	89	54	56	34	176	129	401	...	...	...	...	...	...

HELTZEL BIN EQUIPMENT . . .

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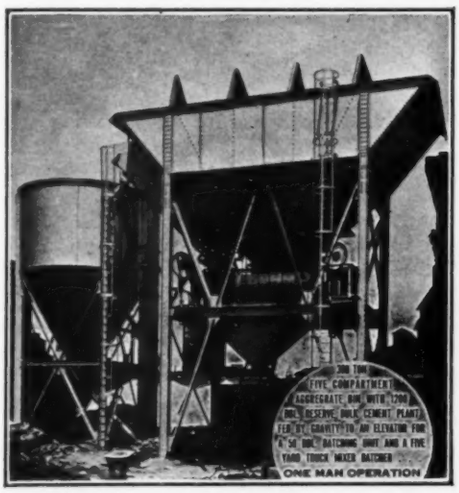

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It will pay you to investigate Jahn trailers.

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"COME TO TRAILER HEADQUARTERS"

Floor System

The floor system of the old bridge consisted of a 2 in. by 4 in. laminated timber floor supported by 9 lines of 4 in. by 16 in. timber stringers on 15 ft. panel lengths.

An analysis of this floor system indicated that the floor beams were safe for an axle load equivalent to the H 15-ton truck, using a stress of 18,000 lb. per sq. in. in bending, while the suspender rods under the same load would be stressed to approximately 20,000 lb. per square inch in tension. Both of these stresses were considered to be within safe limits inasmuch as they are well within the recommended limits proposed by the AASHO Bridge Committee in the "Tentative Specification for Checking Live Load Capacities of Existing Bridges."

The timber floor presented a more difficult problem. Many timber stringers were found to have been broken by the heavy loads, particularly contracting equipment. The discovery of these failures lead to the closing of the structure to heavy loads until repairs could be made.

An analysis of the floor indicated that by adding two lines of new stringers and replacing the broken ones, the bridge would be safe for a 12-ton truck on 2 axles or a 15-ton truck on 3 axles. The new stringers were placed using swinging scaffolds hung from the bridge railings and all new material was handed from the deck of the bridge. The bridge is now posted in accordance with the 12-ton 2-axle and 15-ton 3-axle load requirement and all special permits to cross it are carefully analyzed for compliance with these axle limitations.

Foundation Testing

The conditions of the site, in a general way, dictate the type of structure necessary to replace the present obsolete crossing. The sheer canyon side rock rests, near the floor of the canyon, on a strata of soft shale. This precludes the use of an arch because the arch would spring from about the shale line. A suspension span is not as economical as a continuous girder or cantilever structure, providing suitable foundation for piers are available. Steel construction is more economical than reinforced concrete and since the weather and climatic conditions are favorable to steel, the economical selection resolved itself into a simple determination of proper distance between piers and abutments.

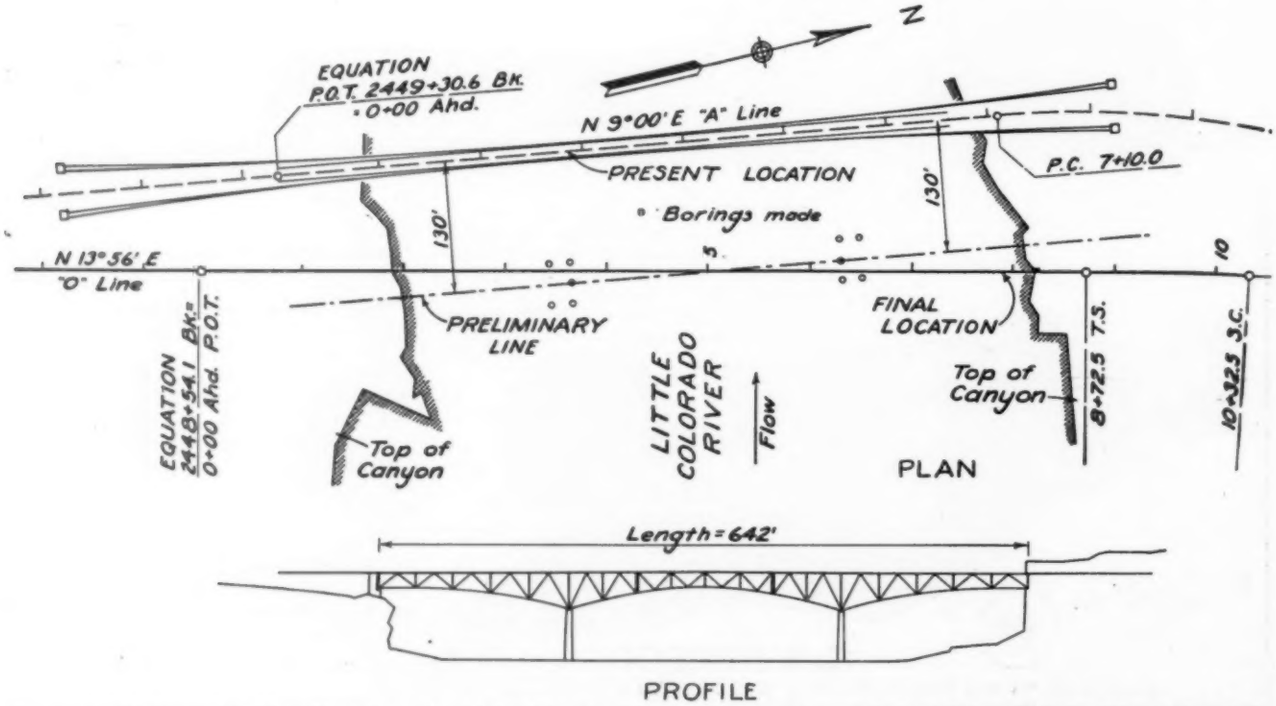
After this calculation was made the bridge department of the Arizona State Highway Commission sent a wash boring drill rig to the proposed pier sites to make foundation tests. The rig consisted of a tripod post framing which supported a block and tackle. A small gas engine driven hoist carried the cast hammer which was used to drive the screw butt jointed heavy pipe 2½ in. casing. The outfit was made in Phoenix where the 350-lb. hammer was cast. The hoist was used for both driving and pulling. The chisel bit contained a side port for introducing water that entered the hollow drill rod at the top. The drill rod was also screw butt jointed. A small Evinrude pump supplied water. To keep the casing joints tight, a man hooked a chain tong near the top and kept turning it to the right during driving. The drop was only 18 in.

Nine holes were put down on the proposed pier site. Table II is a log of the soundings:

TABLE II

No. 1—
0 ft.—Ground elevation—fine blow sand.
16 ft.—Coarse sand.
26 ft.—Gray shale—boulders—fine sand.
30 ft.—Fine sand and gravel—struck clay (No. 5).
31 ft.—Top red clay—1 ft. red clay.
32 ft.—Sand—hard drilling.
33 ft. to 35 ft.—Drilling easier—quicksand.
35 ft.—Coarse sand and gravel.
36 ft.—Top red shale.
37 ft. to 39 ft.—No change.

No. 2—
0 ft. to 11 ft.—Sand.
11 ft. to 30 ft.—Coarse sand and gravel.
30 ft.—Struck conglomerate boulder—casing refused to drive. Drilled 1 ft. 4 in. through boulder and lost water. After hard driving casing broke through and drove easy in gravel to 32 ft.
32 ft. to 33 ft. 6 in.—Hard red shale.
33 ft. 6 in.—Hard blue shale with red streaks—drilled very hard—broke all fittings on drill head.



Present and Proposed Bridge Sites Over the Little Colorado River at Cameron. Lower Part of Diagram Shows Type of Structure Best Suited for the New Crossing. Improved Wide Roads Provide Access to Both Ends of Present Inadequate Suspension Span.

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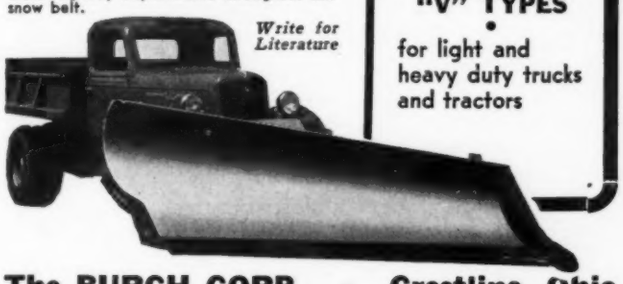

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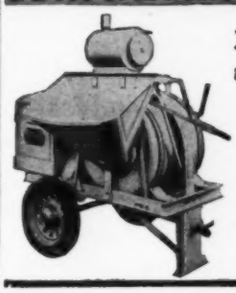

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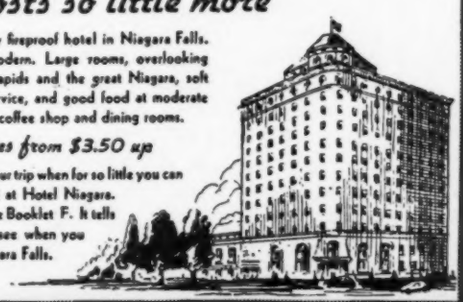

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70 OCTANE, highly anti-knock, ample reserve, quick shipment.

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Mount Pleasant, Texas

No. 3—
0 ft. to 10 ft.—Fine sand.
10 ft. to 23 ft.—Coarse sand and gravel.
23 ft.—Struck boulder—casing refused—drilled to 25 ft.—pulled casing and shot boulder—drove casing back and resumed drilling—drilled to 26 ft.—broke through boulder and casing drove easy to 31 ft.
31 ft. to 32 ft. 10 in.—Hard sandstone.
32 ft. 10 in. to 35 ft.—Soft red clay and shale.
35 ft. to 36 ft. 6 in.—Very hard shale.
No. 4—
0 ft. to 14 ft.—Sand.
14 ft. to 19 ft.—Coarse gravel.
19 ft. to 23 ft.—Fine sand.
23 ft. to 32 ft.—Coarse gravel.
32 ft. to 33 ft.—Hard sandstone.
33 ft. to to 35 ft.—Clay and red shale.
35 ft. to 37 ft. 6 in.—Hard shale.
37 ft. 6 in. to 38 ft.6 in.—Vary hard—broke drill head fitting.
No. 5—
0 ft. to 12 ft.—Sand.
12 ft. to 28 ft.—Coarse gravel.
28 ft.—Struck conglomerate boulder and casing refused—drilled to 30 ft. and broke through and lost water—casing drove hard to 30 ft. and then easy to 31 ft. through gravel.
31 ft. to 32 ft.—Sandstone.
32 ft. to 34 ft.—Red clay and shale.
34 ft. to 34 ft. 8 in.—Very hard shale.
No. 6—
0 ft. to 10 ft.—Blow sand.
10 ft. to 36 ft.—Coarse gravel with occasional layers of fine sand—this sand and gravel contains a small percentage of clay which washes out in small balls but casing drives very easy.
36 ft. to 36 ft. 6 in.—Yellow clay.
36 ft. 6 in. to 39 ft.—Red clay—no red shale as in other holes.
39 ft. to 39 ft. 9 in.—Hard greenish shale.
No. 7—
0 ft. to 12 ft.—Fine sand.
12 ft. to 35 ft. 6 in.—Coarse gravel with occasional streaks of fine sand. Gravel also carries a small amount of clay which washes out in small lumps but drills very easy.
35 ft. 6 in.—Red clay with gravel in first 1 ft.
39 ft. to 40 ft. 8 in.—Hard red shale.
No. 8—
0 ft. to 16 ft.—Fine sand.
16 ft.to 36 ft.—Gravel.
36 ft. to 37 ft.—Hard conglomerate boulder.
37 ft. to 37 ft. 9 in.—Very hard—casing would rebound about 1 in. to 2 in. each blow with hammer. Sand seemed very loose all the way. Less gravel than usual. No clay on bed rock. No clay balls washed out with sand as in holes Nos. 6 and 7.
No. 9—
0 ft. to 20 ft.—Sand.
20 ft. to 24 ft.—Very loose gravel.
24 ft. to 30 ft.—Coarse gravel—lost water.
30 ft. to 36 ft.—Sand and gravel.
36 ft. to 36 ft. 9 in.—Conglomerate boulder.
36 ft. 9 in. to 38 ft.—Very hard shale. This hole showed no clay at any time.

Conclusion.—While roads are in great demand and considerable thought is being given to locations for covering mileages economically, the bridge crossings are often forgotten and neglected; result?—bottlenecks and potential hazards. This old bridge has served its time, paid for itself. Modern traffic and the lure of travel in our historical areas makes mandatory that bridge crossings be as modern as the roads they serve.

▼

NATIONAL SAFETY CONGRESS WILL FEATURE HIGHWAY PROBLEMS

Meeting at the Stevens Hotel in Chicago, October 10 to 14, inclusive, the National Safety Council, which once consisted of two men, a stenographer and a battered typewriter, will hold its Silver Jubilee Congress and Exposition.

Five hundred program participants—chairmen, speakers, discussion leaders and panelists—will swap experiences at 125 sessions. The exhibits, both commercial and contributive, will number 130, including displays and working demonstrations. And there will be plenty of amusement and entertainment.

While the function of the council is to promote safety in all its phases, this year's session will lay special stress on the highway, the vehicle which travels it, and the driver.

The initial meetings of the Street and Highway Traffic Section will be held in conjunction with the annual convention of the Institute of Traffic Engineers for the afternoon of Monday, Oct. 10.

On Tuesday morning, the 11th, there will be separate informal group discussion by persons interested in state safety activities, in safety activities in cities of more than 150,000 and in cities under 150,000, while coincidentally there will be major sessions on Vehicle Safety Fundamentals. On Tuesday afternoon separate sessions will be devoted to the following:

What Data are Needed to Locate the Traffic "Sore Spots"?

Organization, Training, and Equipment for Accident Investigation.

How Accident Investigation Helps Selective Enforcement.

What to Do with the Repeater.

Court of Inquiry on Vehicle Accidents. (A demonstration.)

Open Forum on Vehicle Safety Problems.

The program for Wednesday, Oct. 12, includes informal meetings for the following special groups:

Traffic Court Judges and Prosecutors.
State Highway Officials.
Directors of Public Safety (City and State).
City and State Traffic Police.

And major sessions listed as Testing the Drunken Driver; Regulating Speed for Safety; What Can We Do About Night Accidents?; Vehicle Personnel Problems; Supervision of Drivers Away from Home Terminals; The Safety Director's Daily Personnel Problem (a demonstration); Truck Safety at Home and Abroad; and What About Tires?

Informal meetings scheduled for Thursday, the thirteenth, are:

Traffic Judges and Directors of Public Safety.
City Police and City Traffic Engineers.
Motor Vehicle Administrators, State Police, and State Traffic Engineers.
Managers of Traffic Safety Organizations.

Subjects of other sessions on this date are listed as—Needed Improvements in Vehicle Design and Construction, and Worth While Accessories for Safety—from the Viewpoint of the Driver-Operator; and The Driver—Panel Discussion of such problems as:

(a) Handling the "Prominent Citizen" Violator.
(b) Handling the Impecunious Violator.
(c) Traffic Schools for Adults.
(d) Detecting the Potential Violator and the Accident Prone Driver.

For Friday, the last day of the congress, there will be a joint session with the Child Education Section, with the Bicycle Problem, the Driver of the Future, and the Use of Data in the Safety Educational Program, as special subjects.

We regret our lack of space to name the various speakers and presiding officers, but it is noteworthy that the list includes, chief engineers of the state highway departments, an eminent psychologist, traffic court judges and prosecutors, traffic engineers, corporation traffic managers, mayors, police commissioners.

GIVE AN OPERATOR
A MACHINE HE LIKES
AND HE WILL GIVE YOU
YARDAGE THAT PAYS
BID THE Buckeye WAY
ask for our operation data before you bid
Buckeye Clipper
CONVERTIBLE
EXCAVATORS
with "MEVAC"
METERED VACUUM CONTROL
1/2 YD.
5/8 YD.
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Excavating machinery pays its owner in proportion to its workability—adaptability and stamina but most of all in handling the Clipper—they get to like its control "feel"—easy—positive—accurate—dependable—they can turn in a day's work they're proud of, and yardage that's profitable — the fatigue of manual control is gone.
The Clipper is the kind of a job you should see before you buy any excavator this year. Write, wire or phone today.
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For 30 Years, The Leaders

In every state with a snow removal problem, you will find Baker Snow Plows built by pioneer snow plow manufacturers. If you need new snow removal equipment—reversible or one-way tripping blade, landside or V-type—there's a Baker Model that will do the job better and last longer. You get a good fit on your truck and the most efficient hydraulic lift. Select from 21 outstanding models for trucks of 1½ ton capacity up to the largest heavy-duty trucks.

THE BAKER MFG. CO.
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COOL IN SUMMER WARM IN WINTER

De luxe accommodations at rates much lower than for comparable accommodations in the United States. English inquiries answered in English.

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Built to do a... BETTER JOB!

Sturdy construction combined with many modern and exclusive features of design account for Huber's lower operating costs—lower maintenance—plus the extra speed which enables it to do a better job in less time. Huber Road Rollers invite comparison. Buy by comparison—and you will buy a Huber. Write for Bulletins describing these modern machines in detail.

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6 Sizes from 5 to 12 Tons Gasoline or Diesel.

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CONTRIBUTED EDITORIAL

Need for Uniform Legislation GoverningHighway Transport Units in Western States

IT is granted that conditions connected with highway freight transportation are different in each of the states, but the same is also true in different sections of any one state. In California, for example, there are large agricultural sections such as the Central Valleys and the Imperial Valley, business and manufacturing areas such as the San Francisco Bay district and the Los Angeles metropolitan area, mountain areas having relatively small population but with heavy hauling due to logging and mining and sparsely settled desert country which but adds distance to the haul between producing areas and the consumer.

There can be no argument with the present importance of hauling freight over the highways and there appears to be no desire on the part of any section of the country to radically change or cripple the existing traffic organization. The importance of being able to haul over the highways was demonstrated in California during the past winter when floods played havoc with both highway and railroad transportation. The highways on account of their greater flexibility with regard to restoring and handling traffic were able to serve and handle all freight and passenger traffic until the railroad service could be restored. The railroad between Willits and Eureka, for example, was out of commission nearly all last winter and all traffic into that section of the Redwood Empire was handled over the state highway, even though it was suffering from the effects of an "unusually" wet winter.

Highway carriers, in conformity with the existing vehicle laws, have invested huge sums of money in equipment used for heavy hauling, and it is hardly right that such investments, made in good faith, should be lost through radical and unreasonable changes in the existing regulations. However, the cost of properly maintaining the existing highways and keeping the bridges safe for such loads as now travel them is a matter of grave concern. Therefore, the problem is to set up suitable regulations and limiting factors for highway vehicles which will not jeopardize the money invested in them or unnecessarily cripple the present service and, at the same time, will not impose too great a burden in connection with the construction and maintenance of the highway systems in each of the states involved. It should be possible to take care of the diverse conditions found in the individual states in the same manner that such conditions are now handled in each of them; that is, by establishing suitable general limitations to cover the area in general and taking care of highways and bridges which are not capable of giving full service by the application of local restrictions.

The adoption by the Western Association of State Highway Officials of a code covering the size and weight of motor vehicles is, of course, only one step in the attainment of uniform practice in this respect. The proposed code must be adopted by each state through changes in its present motor vehicle laws and such legislation takes time. However, it is a big step in the right direction and one that should ultimately bring on the desired results.

Having set up a code of uniform procedure, and its adoption by the several states being under way, there will be a natural tendency on the part of manufacturers and operators to build and to purchase new equipment which conforms to the recommended practice. It is to be hoped, however, that changes in the present laws will not have to wait until most of the existing equipment is replaced, and in order to avoid this it is necessary to set up a reasonable period of time in the law for its replacement so that owners of too large, too heavy or too short-coupled vehicles will not suffer too great an economic loss. The laws should state a definite date when all vehicles which do not conform must be replaced or altered and not try to take care of the situation by exempting vehicles registered prior to the passage of the law. It has been found in California, where date of registration governs, that truck owners are able to circumvent the intent of the law by maintaining the original vehicle registration through the replacement of its parts amounting to virtually complete reconstruction.

The existing laws governing the limiting weights for highway vehicles in practically all States, have resulted from periodic legislation which has given little consideration to the effect of such loads upon highway bridges. The stress in each member of a bridge is affected by the spacing and grouping of several axle loads as well as by the weight on the individual axles whereas the stress in the pavements and other road surfacing is primarily a function of the wheel load alone and secondarily of the area over which the load on the tire is spread. Present laws definitely limit gross and axle loads, but regulation of axle spacing is generally left to be governed by the economics of truck manufacture and payload distribution, and, by requirements imposed by safe operation and speed of traveling. It will be realized that the limitation of loads upon highway pavements is chiefly a matter of the cost of maintenance on a road built at a reasonable first cost. However, overloading a bridge may result in its complete failure, with serious damage to the vehicle crossing it and possible injury or death of its occupants. Conditions on the state highways of California are closely representative of those on the state highways of other states and on its state highways over 10 per cent of the bridges have been found unsafe for the legal loadings and have been posted accordingly. The posting of these bridges limits the hauling on many miles of adjacent highway. The safety factor on another 20 per cent of its bridges is reduced to the point of causing excessive maintenance and bringing on rapid deterioration. This, in a rel-

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Stands for the best finishing machine money can buy, also for the all-around best joint—"ribbon dummy joint". Let us serve you too.

FLEXIBLE ROAD JOINT MACHINE COMPANY
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LIGHT AND HEAVY DUTY TRUCKS AND TRACTORS

Ross Snow Plows lead again—in design, rugged construction, greater durability, economy and fool-proof performance. Also spreaders for ice control. Write for NEW CATALOG.

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★COMFORT
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810 OUTSIDE ROOMS
EACH WITH COMBINATION TUB & SHOWER
From $2 Daily
CADILLAC SQUARE AND BATES STREET

DETROIT

Above is a Sauerman Slackline Bucket dumping gravel into hopper on top of plant. Below is a Sauerman Drag Scraper making long side-hill cut.

SAUERMAN
LONG RANGE MACHINES

WHEN you have an excavation job that calls for moving dirt several hundred feet or more, it surely is economy to use a machine that will reach the entire distance and eliminate rehandling.

Sauerman long-range machines will do just that — reach any distance from 100 to 1,500 ft., and handle the digging, hauling and disposal of the dirt in one operation.

Use a Sauerman Slackline Cableway if your work calls for digging deep and dumping at a high point.

Use a Sauerman Drag Scraper wherever dirt is to be hauled over the ground, as in making cuts and fills, moving gravel from a bank, pit or stream to crusher, etc.

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atively few years, will require the expenditure of millions of dollars for the replacement of these bridges or make it necessary to post them for reduced load limits. The cost of replacing all these sub-standard bridges in California has been roughly estimated to be $35,000,000 with an additional indefinite expenditure for adjoining highway relocation which will be necessary in order to place the structures on their final location. Since the total amount obtained from motor vehicle revenues that can be used for highway construction in California is about half this amount, it is evident that under these circumstances, the existing condition cannot be remedied for a good many years hence. In many states the present laws permit loadings which encroach upon the normal safety factors which bridge designers have been allowing in preparing plans for new bridges, which safety factors are practically those adopted by the American Association of State Highway Officials. The Bridge Committee of that organization is now giving this matter serious consideration with the idea of recommending a somewhat greater design loading to be used where conditions warrant it. It is interesting to consider one of the main objections that has been raised to this increase in the design loads; namely, that such increase will be seized upon by the trucking interests as an excuse to get the present load limits raised and thus more or less start a vicious circle. While the likelihood of unrestricted or even large increases in the present load limits is remote on account of practical considerations, the question further brings out the need for a uniform opinion and a united action with regard to such limits, and also shows their close relation to the structural engineering questions on bridge design.

In order properly to take care of the factor of axle spacing and grouping, the limitations to be set up should be such that the weight will vary with the axle spacings in approximately the same ratio as do the stresses in bridge members for structures of all span lengths. This, of course, cannot be done so as to fit accurately all possible conditions without making the rules so complicated that their application would be impractical. However, the requirements can be met within practical limits by taking account of all the different factors which relate to, and do in some way limit the maximum loads and minimum spacings. It must be remembered that any regulation of loads by the use of formulae or specific limitations must be easy to understand and convenient to apply without the user having special knowledge of the scientific or engineering principles involved.

Since the existing laws in some states allow the same gross load on a given type of vehicle regardless of the length of vehicles, the application of a rule which will cause this load to vary with the axle spacing will require some changes in the loads that can be carried by some of the vehicles of that particular type or combination. It is not unreasonable, in attempting to maintain the status quo, to ask that owners of existing trucks accept a slight reduction in gross load for short coupled vehicles, which the commonly used formulae may require, and allow the average vehicle about the same gross load as many states now permit on all vehicles of a given type. In following such a procedure it will, of course, be possible for the long coupled vehicles to carry a slightly heavier load than is now permitted them. The commonly used type of formula, in which the allowable weight is equal to a constant times L plus 40, has certain advantages during a period of transition of the vehicle laws. The reduction in the load for the short coupled vehicles of any of the common combinations does not appear to be large enough to cause any great hardship, and although it does not reduce the loads at as great a rate as the requirements of uniform stresses in bridge structures would call for, it may be considered a fair compromise which can be met by both the vehicle owner and the highway engineer.

The above gross weight formula, if it is applied only to the overall distance between front and rear axles of vehicles or vehicle combinations, does not provide enough control to insure uniform stresses in bridge structures of varying span lengths. A limiting load on one axle and wheel which is required for the protection of road surfaces furnishes an additional limitation directly affecting bridge stresses but it is still necessary to further limit close groupings of axles within the overall length. Oregon has suggested that the same formula with a lower coefficient be used for all groups of axles contained within a distance of 20 ft. or less.

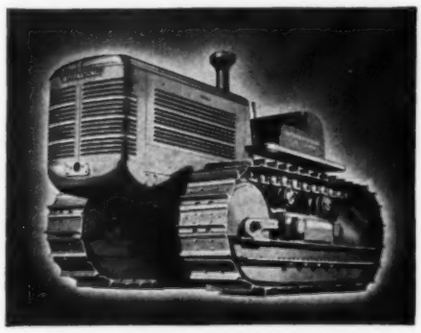
One difficulty with this method is that present day trucks have groupings of axles which may vary gradually in the vicinity of a length of 20 ft. and thus make a radical jump according to whether the length is slightly above or below that figure. This is particularly the case in connection with the rear wheels of the tractor and the semi-trailer wheels in a 3S2 type vehicle. Another method which has been proposed and is now used in some states is to apply the formula to any group of three or more axles in the vehicle or vehicle combination, and in addition set certain limits for the total load on dual axles in addition to the single axle load.

Based upon conditions in Oregon, Mr. Paxson recommends a coefficient of 700 for the gross weight formula and suggests that dual axles be limited to 28,000 lb. California now permits 60,000 lb. on 3S2 and 68,000 lb. on 3-3 type vehicle regardless of the axle spacing, and to maintain the status quo by allowing vehicles of average axle spacing these load limits would require the use of a coefficient of about 800. At the same time California only allows 26,000 lb. on dual axles and, in allowing a coefficient of 800, it would be very desirable from the effect on structures to maintain the existing dual axle restriction. If the dual axle limit is raised to 28,000 lb. it would be advisable to lower the formula coefficient to 750 and while such a combination is somewhat better in regard to limiting the stresses in bridge members, it is doubtful if it can be applied in California without very material changes in the present motor vehicle equipment.

NEW EQUIPMENT AND MATERIALS

New Tractor

A new TracTracTor has been announced by the International Harvester Co., 180 North Michigan Ave., Chicago, Ill. This tractor is operated by a 6-cylinder Diesel engine and has a maximum of 70 drawbar



New International Diesel TD-18 TracTracTor

horse-power. It has a 6-speed transmission. Long track ground contact and approximately 21,000 lb. of weight provide traction to match the power of the engine and the requirements of heavy-duty operation. All controls and gauges are within easy reach of the driver. This new TracTracTor —the TD-18—will be the largest in the International crawler-tractor line. As is typical of International Harvester practice, experimental TD-18 models have been spotted on various strategic jobs and for four years have been submitted to all sorts of engineering tests and grueling field work.

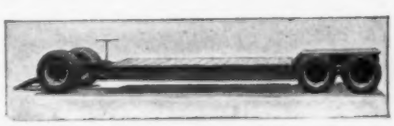
▼

C. R. Jahn Company's New All-Purpose Trailer

Announcement of a new six-wheel "All Purpose" trailer has just been made by the C. R. Jahn Company of Chicago, pioneers in the exclusive manufacture of standard machinery trailers.

This new trailer, which has been designed to transport numerous types of machinery, will efficiently handle loads up to 48,000 lbs. Among the more important features claimed for this six-wheel unit is the same ease of loading that has been available on Jahn "single purpose" trailers, as well as their four-wheel "all purpose" units.

The easy and fast loading method of Jahn trailers is made possible by means of the unique construction at the front end of the trailer frame, which serves as both a connection and turntable for the front axle, and permits the entire front axle assembly



The New Jahn Six-Wheel Trailer

to be removed. Loading is also made easier by means of a heavy jack screw built into the coupling assembly, which raises or lowers the trailer frame to accommodate all jobs with perfect safety.

Two rear axle arrangements are available on this new trailer—either tandem or dual oscillating types, and all wheels are equipped with heavy duty full balloon pneumatic tires.

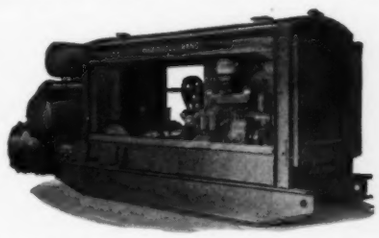
The new unit has been carefully designed to conform to all state regulations covering overall lengths, widths and wheel designs.

Standard equipment includes adequate loading ramps, lash rings riveted to side frames, heavy draw bar safety chains, reflectors, stake pockets and flag sockets.

▼

New Heavy-Duty Large-Capacity Semi-Portable and Portable Compressor

A new compressor delivering 425 cu. ft. of air per minute (actual) at 100 lbs. has been announced by Ingersoll-Rand. Known as the model 425, it is a self-contained compressor-plant, available in portable or semi-portable mountings. The compressor is of the same slow-speed, heavy duty, stationary-type compressor usual for permanent installations. A four-cylinder, heavy-



Ingersoll-Rand Model 425 Compressor

duty tractor-type engine drives the compressor through simple reduction gears. Either gasoline, gas or oil engines can be furnished.

The unit is adapted to contracting and oil-field service.

Copies of descriptive bulletin 2486 may be obtained from Ingersoll-Rand, 11 Broadway, New York City, or any of their branch offices.

▼

Dragline Handles 1½-Yd. Bucket at End of 100-Ft. Boom

Harnischfeger engineers developed this specially designed, 100-ft. aluminum boom for use on the standard P&H Model 955-LC, which normally is equipped with an 80-ft. boom for handling a 2½-yd. bucket. The standard model 955-LC has sufficient power to handle a 3 cu. yd. bucket with 80-ft. boom when necessary. Therefore, it was entirely practical to design a special boom to meet the demands of large scale dirt moving operators in the west for a 1½-yd. machine with excessive reach. This new aluminum type boom is equipped with a stiff leg gantry, which is a main factor in keeping the weight of the boom within the

Cuts Hauling & Dumping Costs

The Brooks LOAD LUGGER

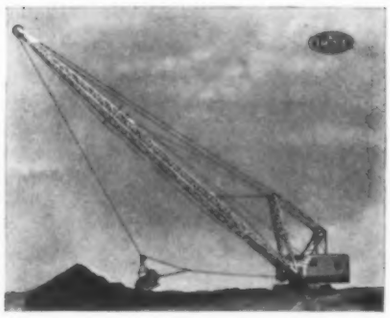
PATENTED — PATENTS PENDING

Don't overlook the cost-cutting possibilities of the Brooks Load-Lugger. It's the most practical, fool-proof, and greatest cost-cutting method known, for hauling and dumping any material where loading is done by hand. One truck with a "litter" of bodies . . . is the Load-Lugger way. Made in four capacities, shipped assembled, ready for installation on any truck chassis in a few hours.

ONE MAN OPERATED from driver's seat. No sheaves, cables, or "gadgets" to worry with. Buckets rest directly on chassis, no suspended load. Its speed and performance is almost unbelievable. For complete details and prices write the manufacturers. Demonstrations arranged in most sections.

BROOKS EQUIPMENT & MFG., CO.

52 Davenport Road, Knoxville, Tenn.



P&H Model 955-LC With Extra Long Reach

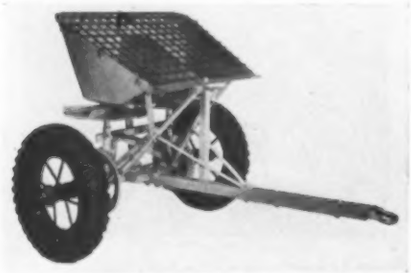
allowable maximum and which practically eliminates bending. This type of boom construction also reduces compressive stresses within the boom members and allows a much higher slenderness ratio—allowing a favorable angle between the boom topping line and the boom at all positions.

This machine is equipped with long crawlers made up of shoes 36 inches in width, and has an all-welded upper revolving deck and frame as well as a completely all-welded lower car body and crawler frame. This new type construction allows its weight to be brought down to about 148,000 lbs. The power plant is a Fairbanks-Morse Diesel.

▼

New Paramount Trailer Spreader

The Peoria Steel and Wire Co., Peoria, Ill., has recently brought out the new general purpose spreader here illustrated. A special feature is a telescopic hitch which permits attachment of the spreader directly to the axle of a truck at any desired distance behind the truck's body. Slide adjustments at the bottom of the hopper provide for the spreading of material in any desired thickness from the thinnest to the greatest thickness which is ordinarily required of a machine of this character. Blade agitators in the hopper secure an even flow to the spreader discs. A 2-in. mesh screen to cover the top of



Paramount Spreader with Rubber Tires and Telescopic Hitch.

the hopper and prevent the entry of large stones is available, if desired. The spreader is provided with a release which throws the mechanism out of gear while the machine is traveling idle.

New Variable Speed Dual-Purpose Spreader

A new, variable-speed, dual-purpose spreader has been added to the Warco line of road building equipment of the W. A. Riddell Corporation, Bucyrus, O. The new spreaders, which will be known as the Warco-Hartley spreaders, are built in three types. The Model H is the regular type. The Model M is the transmission type and affords eight different speeds and enables same to be operated up to a speed of 35 miles per hour. The third type is the Model M transmission type, equipped

New Warco Dual-Purpose Spreader

with an independent motor (as shown in accompanying illustration), for driving the disc in spreading exceptionally heavy material such as black top chips. These spreaders are stated to have a number of distinctive features, in that the width and thickness of the spread can accurately be controlled by the amount, speed and position with which the material is fed to the disc, which insures an even distribution of the material from 6 to 30 ft., depending upon the character of the material being spread. The spreader is designed for use behind a truck traveling on the righthand side of the road, and discharges material behind and to the left of the truck. Discharge is arranged low enough so as not to interfere with passing traffic. An automatic hitch makes possible quickly detaching from one truck and changing to another. In territories where a winter-long fight against ice or hard packed snow and slippery pavements is necessary, the Warco-Hartley spreader will quickly spread the necessary sand, cinders, chloride or salts. It is also excellent for spreading chloride or other dust laying materials in summer; birdseye stone or black top chips; and excellent for agricultural lime or fertilizer.

▼

New 14-S Mixer

The T. L. Smith Company, Milwaukee, Wis., announces a new 14-S non-tilt mixer in 4-wheel end or side discharge model. The new machine is said to incorporate many refinements that speed up all three phases of the batch cycle-loading, mixing and discharging. Like all Smith mixers, it has an "End-to-Center" mixing action. 10 full-width buckets continually work the batch from the ends to the center.

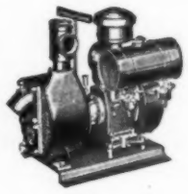
New Smith 14-S Mixer

The drum is unusually narrow with an extra large diameter and bigger drum openings. The complete machine is of sturdy all steel construction. Compact. Lightweight. Features include: Single center gear ring and roller tracks, drum rollers turning on dustproof ball bearings, enclosed gear reduction, multiple "V" belt drive, outside band clutch and skip brake, oversize streamline skip equipped with automatic skip vibrator, accurate syphon-type water tank, auto type steering, spring mounted axles, anti-friction bearings throughout.

▼

New Lightweight Pump

A new lightweight self priming centrifugal pump designed to handle dirty, muddy water containing large amounts of solids, has been brought out by the Sterling Machinery Corporation, 411 Southwest Blvd., Kansas City, Mo. The pump is made in two models: Model LTL of aluminum construction, net weight 100 lb.; and Model LT, semi-steel construction, net weight 140 lb. The pump has a 2-in. suction and a 2-in discharge. It is equipped with Lauson single cylinder 4-cycle air cooled engine with high tension magneto, mechanical governor, automotive type carburetor and ball bearing crankshaft. The pump has round, self-cleaning pump case, wide blade open trash type impeller, improved shaft seal, and swing check valve built into suction connection to retain prime in pump and suction line.



New Sterling Pump

▼

Simultaneous Multiplication and Division

A simple device anybody can operate, invented by F. A. Belt, Mt. Washington, R. 8, Cincinnati, Ohio, conssits of a card 2 in. x 11 in. on which is printed a reading base of readymade products of the numbers 1 to 12 multiplied 100 times. If three horizontal alignment markers are

used, the power of the base is increased one thousand times; or, the product of six figures multiplied by one figure at a time is read direct. Division by any two figures produces a simultaneous multiplication by any other two figures.

▼

WITH THE MANUFACTURERS

Spears-Wells New Representative for Ransome

The latest addition to the lineup of representatives for Ransome Concrete Machinery Co., Dunellen, N. J., is Spears-Wells Machinery Co., 1832 W. Ninth St., Oakland, Calif. They will handle the complete Ransome line of concrete machinery in the San Francisco territory.

▼

W. F. Hosler Dies

W. F. Hosler, chairman of the board of directors and former president of The Buckeye Traction Ditcher Co., Findlay, O., died at his home in Findlay on August 20, 1938, at the age of 78. As a member of the board of directors and as president of the company since 1913, Mr. Hosler was long active in the affairs of his company. In January, 1937, he was elected chairman of the board of directors. Though confined to his home for about a year prior to his death, Mr. Hosler continued active participation in industrial and civic affairs.

▼

C. A. Van Dusen, Pioneer Gar Wood Distributor, Dies

C. A. Van Dusen, president of Van Dusen Auto Repair and Machine Company, Toledo, Ohio, died during the month of August. Mr. Van Dusen was associated with the hoist and body division of Gar Wood Industries, Inc., for many years, being one of the very first distributors for the old Wood Hydraulic Hoist and Body Company, former name of Gar Wood Industries. He was a lovable character, fine type of business man, and held in high esteem by all who were closely associated with him. His passing will be felt keenly by all his friends and business associates.

▼

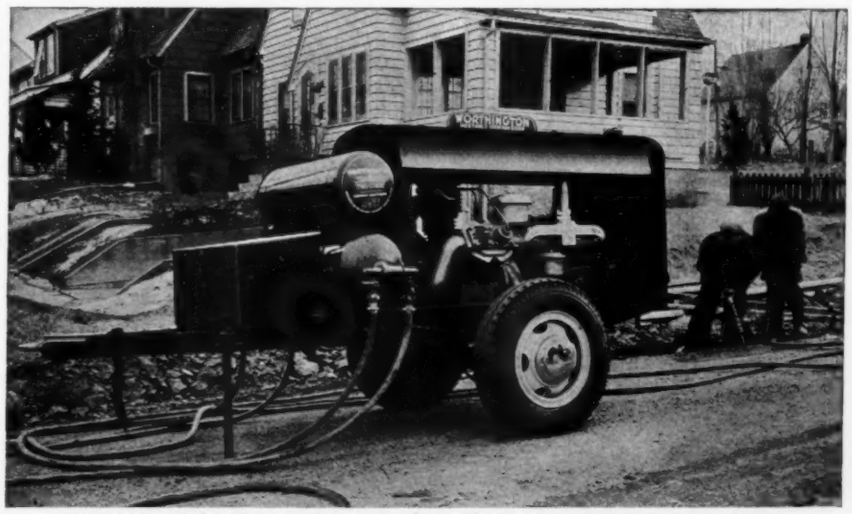
New Denver Agency Handles Varied Lines

Power Equipment Company, 2120 Delgany Street, Denver, Colorado, was organized on June 1st, 1938, under the active management of Mr. George A. Leonard, who is well known among those engaged in industrial power activities.

The new firm, now the Colorado State distributors for the International Harvester Company's line of tractors and power units, will handle the Bucyrus-Erie line of bulldozers and scrapers. In addition, the company will also distribute the Heil Company scrapers, dump bodies, truck tanks and snow plows. Other added lines will be those of the Trackson Company, the Hughes-Keenan Company, the "Shop Mule" tractor, and the Dorsey line of truck and tractor equipment.

THEY'LL GET THE JOB DONE
...On Time...Profitably

WORTHINGTON Portable Compressors will save time, labor and overhead expense. Ask for a demonstration on any job ... on road work, pavement breaking, drilling, sheeting driving, trench digging, tamping.

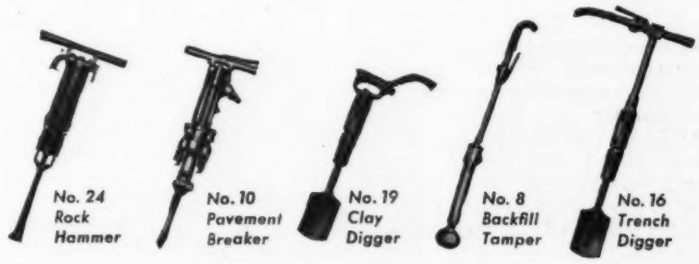


Worthington 105-cubic-foot Trailer, operating Worthington Breaker and Digger

PORTABLE COMPRESSORS
60, 105, 160, 210, 315 CU. FT. ACTUAL CAPACITY
Gasoline engine or diesel engine drive
All types of mountings

SEMI-PORTABLE COMPRESSORS
FOR ANY CAPACITY
Gasoline engine or electric motor drive through Multi-V-Belt

Worthington rock drills, breakers, drivers, diggers and tampers are further aids to profitable operation.



No. 24 Rock Hammer — No. 10 Pavement Breaker — No. 19 Clay Digger — No. 8 Backfill Tamper — No. 16 Trench Digger

There's a Worthington Dealer near you

WORTHINGTON PUMP AND MACHINERY CORPORATION
General Offices: HARRISON, NEW JERSEY
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WORTHINGTON

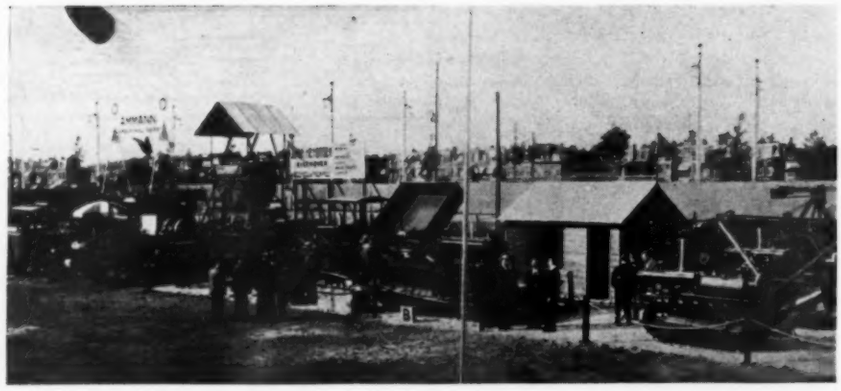
PCB-14

Jones & Laughlin's New Wire Rope Division and Robert Gilmore, Its Head

In their program of expansion, the Jones & Laughlin Steel Corporation has entered into the wire rope market, with a new, modern plant, and with every machine a precision instrument.

This plant will be known as the Gilmore Wire Rope Division of the Jones and Laughlin Steel Corporation. Mr. Robert Gilmore, general manager of the division, has devoted his entire business life to the development and manufacture of wire rope, and is an acknowledged leader in the industry. Together with his engineers, he recognized the need for entirely new precision machines to meet present day demands, the outcome of this recognition being the new J. & L. plant.

Robert Gilmore



At Caterpillar Tractor's Exhibit, International Road Congress, June, 1938

The New Wire Rope Plant of Jones & Laughlin Steel Corporation at Muncy, Pa.

This plant is indicative, also, of an expansion and development program carried on by Jones & Laughlin under the direction of Mr. H. E. Lewis, its president, who says:

"The entrance of J. & L. into the manufacture of wire rope enlarges considerably our opportunity for satisfactory return on raw materials and for better operations of our rod and wire mills. The plant at Muncy, Pennsylvania, is new in all respects and incorporates features for the manufacture of products having superior qualities that will assure our immediate participation in all major markets for wire rope.

"In Robert Gilmore, General Manager, we have an outstanding leader in the wire rope industry to head this new Division."

▼

Caterpillar Tractor Company and Associates Enjoyed Attention at the Hague Conference

The view herewith shows the Caterpillar Tractor Co.'s exhibit, some of its officers, and other road builders at the International Road Congress held at The Hague, Netherlands, in June of this year.

Approximately 4,000 engineers from 45 countries throughout the world attended the Congress.

Caterpillar Tractor Co. maintained a large display of diesel-powered tractors, auto patrols and blade graders. Sharing the exhibit were scrapers, wagons, bulldozers, winches, etc., from LaPlant-Choate, LeTourneau, Hyster, Athey and other allied equipment manufacturers.

Among those attending the Road Congress from "Caterpillar's" main factory at Peoria, Ill., were B. C. Heacock, company President; J. D. Fletcher, manager of the Export sales department, and J. Q. McDonald, assistant export sales manager.

In the foreground of the photograph, Mr. Heacock is talking to M. D. Van Wagoner, president of the American Road Builders Association, and Mr. Kishing of the American delegation.

▼

Worthington Makes Changes in Oil and Gas Engine Sales Personnel

J. C. Barnaby, former manager of Worthington Pump and Machinery Corporation's Oil and Gas Engine Application Division at Buffalo, New York, and responsible for engine sales in the Central Division, is being placed in charge of special engineering work covering engine research and design, and will devote his entire time to this activity.

W. E. Wechter, in charge at New York of the Corporations' engine sales in the Atlantic Division, has been transferred to Buffalo to succeed Mr. Barnaby.

He will be assisted by J. F. Hecking, who continues in his present capacity of assistant manager of the Oil and Gas Engine Application Division.

In the Atlantic Division, oil engine sales will be covered by H. C. Wood at New York, while W. L. Russell, at Harrison, New Jersey, will take over the gas engine sales. This latter assignment is in addition to Mr. Russell's present responsibilities as manager of the Eastern Division of Worthington Oil and Gas Power Sales.

▼

New Distributors for Osgood

The Osgood Co., Marion, O., has announced the recent appointment of the following distributors to handle the complete line of Osgood power shovels including Invader shovels and truck cranes: C. B. Skinner Co., New Orleans, La.; Morton & Morton, San Antonio, Texas; W. A. Akhurst Machinery Co., Ltd., Vancouver, B. C.; Rome Tractor Sales Co., Rome, N. Y.; A. L. Crow Road Mchy. Co., Birmingham, Ala.; Industrial Machinery Co., Kansas City, Kansas. All these firms are now in position to furnish catalogs, specifications and prices on any of the above equipment in their respective trade areas.

▼

Ralph J. Reich Appointed Buffalo Branch Manager for Gar Wood

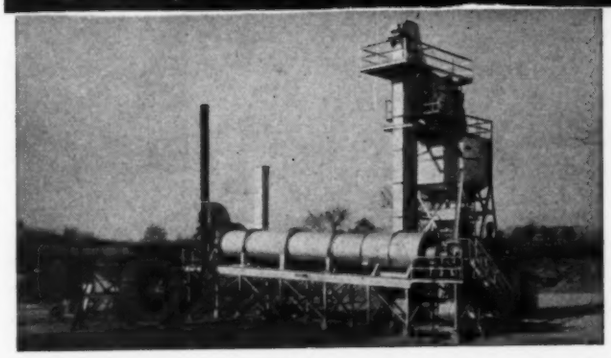
W. H. Hammond, Sales Manager of the hoist and body division of Gar Wood Industries, Inc., Detroit, Mich., has announced the appointment of Ralph J. Reich as manager of the Buffalo branch. Mr. Reich has been connected with the Buffalo branch for a number of years in the capacity of assistant manager. In addition to his duties as branch manager, Mr. Reich has supervision of the Syracuse, Rochester and Buffalo territories.

▼

Covic Diesels to Be Manufactured in California

An immediate production program of more than a million dollars worth of Diesel engines has been announced by John K. Northrup, vice president of the Northill Company, Inc., prominent Los Angeles manufacturer of equipment for the aircraft and marine industries. Northill Company has acquired exclusive, national

ASPHALT PAVING MACHINERY



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"IT ABSOLUTELY WASTES NO STONE OR SLAG"

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An Ohio contractor makes these statements after using the Buckeye Surface Material Spreader on County maintenance work. Others from coast to coast and Canada to Mexico make equally convincing reports of its value to them on surfacing work.

Write for data and prices before you invest in spreaders this year.

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OTHERS SAY

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"The Buckeye is the only spreader I have ever seen that can be controlled perfectly."

"It is the best spreader I have ever seen in more ways than one."

"Accuracy—time saved—but most important is—it satisfies engineers."

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Built for Highway Mowing
TORO ROUGHMASTER

The need of heavy, cumbersome farm or industrial tractors weighing upwards of three thousand pounds is over as far as mowing is concerned.

Note these specifications—

- a wheel base of only 71 inches.
- a turning radius of 6¾ feet.
- a speed range up to 15 miles per hour.
- a new improved sickle bar with a cutting range from 45° above to 40° below horizontal.
- controls that anyone can drive without special training.
- a normal life of ten years or more.
- a common sense low price.

There is a tremendous interest this year in Highway Mowers and the Roughmaster is the answer to the many requests for a light, strong, easily handled machine, and at a price that every State and County can afford.

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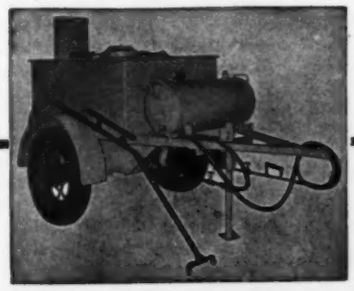
Minneapolis **Minnesota**



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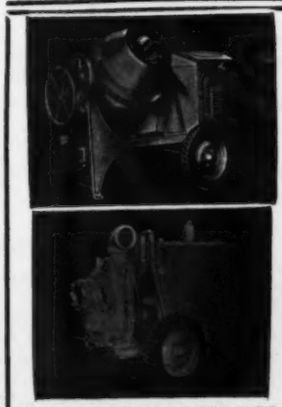
FIRE PROOF—OIL BURNING
Hand and Motor driven spray.
Many sizes. Write for catalog.

Elkhart White Mfg. Co. **Indiana**



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CONSTRUCTION MCHY. CO., Waterloo, Iowa

manufacturing and sales rights for the Covic Diesel engine. Cylinders on the Covic Diesel are horizontally opposed, of the "pancake type." This engine was originally developed in England and thousands are in use throughout the world, for marine, stationary and automotive power. John K. Northrop, former president of the Northrop Corporation and vice president of the Douglas Aircraft Co., Inc., is vice president and executive engineer of the Northill Company. The Northill Company, through its sales director Ed Zuchelli, announces that a national organization of distributors and dealers, to serve all power-using industries, will be established immediately. Distribution has already been arranged for the Pacific Coast territory, through the Covic Diesel Pacific Company. The firm is headed by James Garvey, prominent in the Diesel engine business for the last 25 years. Initial commitments of Pacific Coast dealers represent more than half a million dollars. Production of this new Diesel is already started in the plant of Menasco Manufacturing Company, to which Northill Company has awarded an initial contract for one thousand engines. The Covic will be manufactured in a complete range of models for all applications, from bare engine, through engine-and-clutch units, to complete power units with radiator. An automotive model with 4-speed transmission will also be in the Covic line. All models will be sold for original installation by manufacturers in their equipment, as well as for replacement purposes by present owners of powered equipment. Models of the Covic Diesel are built for powering such equipment as compressors, conveyors, concrete mixers, pumps, small rollers, small tractors, trenchers, and welders, and many other types of equipment, both mobile and stationary. Covic Diesels will also be available in complete DC and AC generator sets for the supplying of low cost power and light on location.

▼

Cummins Engine Fills Large Orders and Expands Plant

With orders to dieselize the equipment of three of the largest contracting concerns in New York the Cummins Engine Company of Columbus, Indiana, is pleasurably busy.

During the last thirty days, the company has received orders for 112 engines for the Colonial Sand and Stone Company, Inc., of New York City, the largest concern of its kind in the United States. Sixty-two were for the four-cylinder model for replacements in old trucks, and fifty of the six-cylinder model will be installed in new Mack Trucks now being built at the Mack factory in Allentown, Pa. The fifty new diesel-powered trucks were purchased by the New York concern at a cost of approximately $500,000.

Up to two years ago, the diesel powered dump truck field was a comparatively new one for the Cummins Engine Company. Contractors had contended that because of the short hauls usually made by dump trucks, diesel power would not be economical in proportion to its records on high-speed, long haul work. However, experiments made by these and other concerns in metropolitan New York, and by general contractors on large dam jobs covering periods of a few months to two years, proved the practicability and economy of the diesel engine for the short haul.

Upper View: One of Colonial Sand and Gravel Co.'s Trucks on Which the Diesel Was Given a Long Trial Before Order Was Placed. Lower View: Installing 4-Cylinder Cummins Engine in One of Colonial's Dump Trucks

A pioneer builder of diesel engines, the Cummins company is now operating on the largest production schedule in its history and is carrying on an extensive expansion program. Additions to two of the present buildings are being constructed, and work on a new and strictly modern factory building in which nothing but the Cummins diesel fuel system will be manufactured is scheduled to start immediately.

P. E. Letsinger, Vice-President in charge of sales, states that the company plans to double its present production during the next twelve months. This will be due to a new smaller diesel engine built in four and six-cylinder sizes (4-in. bore and 5-in. stroke) which has just started to come off the line. A further improvement in the fuel system is said to eliminate all objectionable smoke and odors, thus making the engine especially adaptable for city busses operating in heavy traffic. It is stated that at a small cost, the improved fuel system can be adapted to all Cummins diesels now in service.

▼

Donald C. Bakewell Elected to Blaw-Knox Directorate

Blaw-Knox Company today announced that Donald C. Bakewell, vice-president, was elected a director of the company at the last meeting of the Board of Directors. Mr. Bakewell became affiliated with Blaw-Knox Company early in 1937, being engaged in a sales capacity, and was elected a vice-president on June 22, 1937.

Donald C. Bakewell

Mr. Bakewell graduated from Yale with the class of 1908 and took post graduate training at the Massachusetts Institute of Technology. His business experience has been in the steel manufacturing field and allied lines, involving the presidency of a local steel foundry, and for a term of 10 years, the presidency of a local forging company. Immediately prior to joining Blaw-Knox Company, Mr. Bakewell was first vice-president of a western roll and machine company.

▼

American Rolling Mill Establishes District Office in Minneapolis

The American Rolling Mill Company, Middletown, Ohio, is establishing a District Sales Office in Minneapolis, according to an announcement by H. M. Richards, Manager of the Sheet and Strip Sales Division.

W. A. Danner, now connected with the company's Chicago office, is District Manager. Mr. Danner, who has been associated with "Armco" for the past 16 years, first in the plant at Middletown and later in various positions in the sales division, will be assisted by S. A. Yager. Mr. Yager has been connected with the company for the past nine years, also first in a plant position and later as a member of the Chicago district office organization. In recent years Mr. Yager has been located in Minneapolis.

▼

Marmon-Herrington Official Heads National Veterans Association

Daniel I. Glossbrenner, secretary-treasurer of the Marmon-Herrington Company of Indianapolis, Indiana, manufacturers of all-wheel-drive trucks nad track-laying tractors, was elected president of the National Association Rainbow Division Veterans at its July meeting in St. Paul, Minn.

Mr. Glossbrenner served as a second lieutenant with Battery A of the Indiana Field Artillery on the Mexican border in 1916 and 1917, and went overseas as a captain with the 150th Field Artillery which was a part of the Rainbow Division (42nd). During his 18 months' overseas service in France, Belgium and Germany, as a part of the army of occupation, Mr. Glossbrenner witnessed the introduction of motorized equipment in army service and became keenly interested in the advantages to be secured with the proper equipment. The opportunity for him to capitalize fully on this interest came in 1931 when he joined the Marmon-Herrington Company which was manufacturing a line of all-wheel-drive vehicles designed by Col. A. W. Herrington.

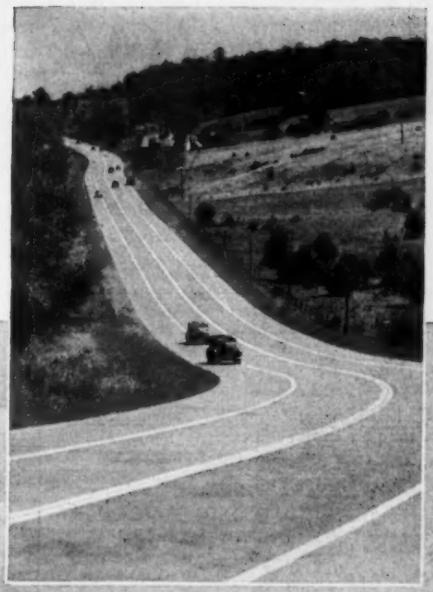
▼

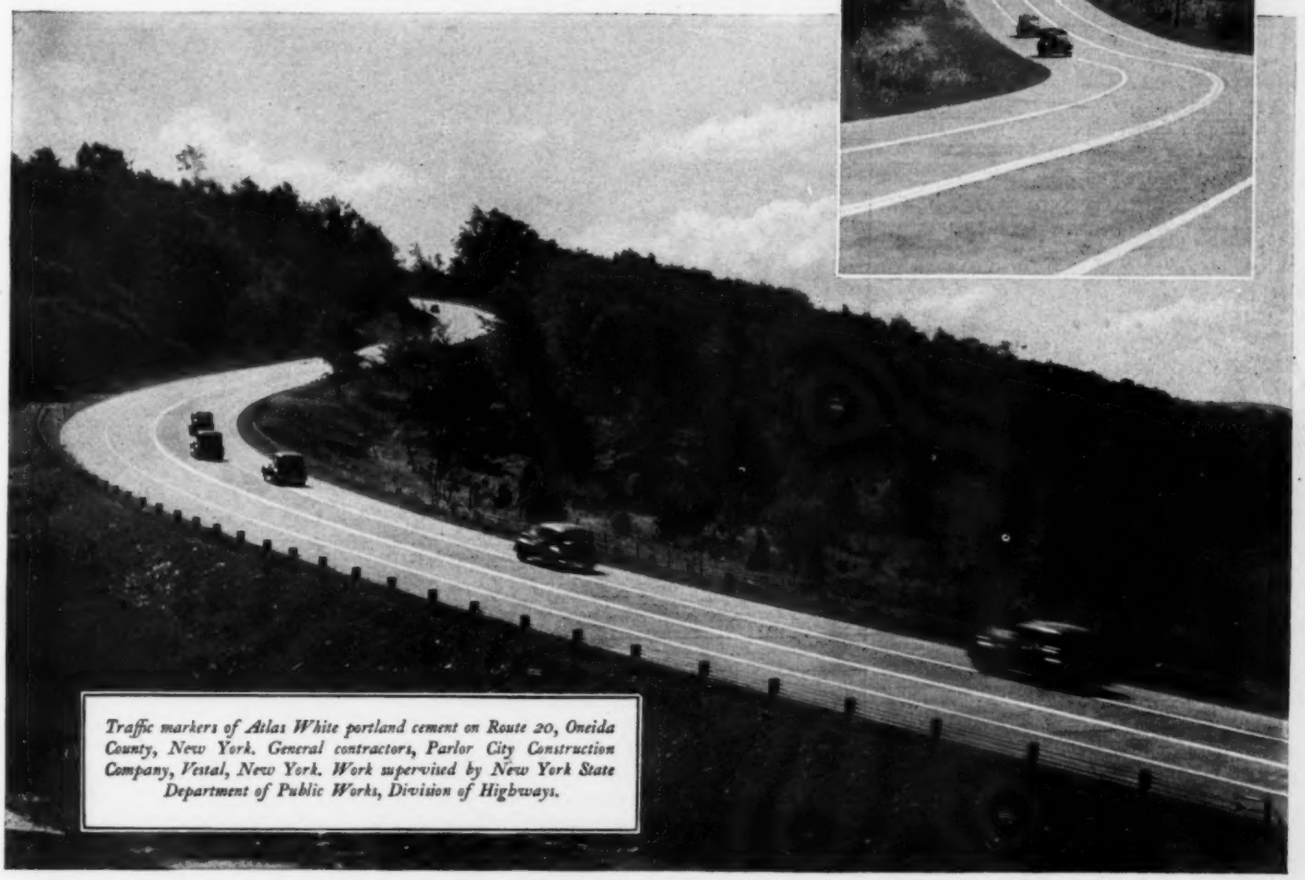
Hugh J. Baker Dies

Hugh J. Baker, Treasurer of The Concrete Reinforcing Steel Institute, died suddenly at Indianapolis on August twelfth.

Swell Marker Job

—*and it will pay for itself*





Traffic markers of Atlas White portland cement on Route 20, Oneida County, New York. General contractors, Parlor City Construction Company, Vestal, New York. Work supervised by New York State Department of Public Works, Division of Highways.

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